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The state of the art of autoinstruction and teaching devices is summarized, and instructional devices developed through April 1961 are cataloged with the aim of suggesting possible applications to local training or educational problems.

In the first section, an overview of autoinstruction is presented. The instructional presentation is aimed at the individual student. It involves a closed loop with feedback control over the learning process, provides constant testing of the proficiency being attained by the learner, and allows for modification on the basis of student errors. Although it is not a new concept its novelty derives from the systematic application of learning principles. Practical benefits are presented under the categories of efficiency, economy, and flexibility of operation. Such specialized terminology as programing, linear and branching techniques, frames, and types of responses are defined. The programing formats involved in the major schools of thought (the Pressey, Skinner, Crowder, and Pask formats) are discussed. Evaluation criteria are divided into four aspects considering the level of proficiency to be expected, the composition of the group for which the efficacy of the program is demonstrated, the amount of time required to achieve the specified level of proficiency, and the cost per student-hour. Among the considered future directions of programing are the continued emphasis on verbal or symbolic types of learning along with application of the techniques to motor skills, and the greater role to be played by digital computers.

In the second section autoinstructional devices of major importance as of 1961 are cataloged and described. These include Skinner machines, Pressey machines, Crowder techque, self-organizing systems, audiovisual machines, digital computers as teaching machines, and miscellaneous devices. A list of teaching machine patents is given.

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A SURVEY OF AUTO-INSTRUCTIONAL DEVICES

FELIX F. KOPSTEIN
ISABEL J. SHILLESTAD

BEHAVIORAL SCIENCES LABORATORY
AEROSPACE MEDICAL LABORATORY

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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This report summarizes the state of the art of auto-instruction and teaching devices and catalogs instructional devices to April 1961, in the interest of suggesting possible applications to local training or educational problems. The first section briefly reviews what auto-instruction is, whether it is an entirely new

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FELIX F. KOPSTEIN
ISABEL J. SHILLESTAD

BEHAVIORAL SCIENCES LABORATORY
AEROSPACE MEDICAL LABORATORY

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FOREWORD

This report was prepared under Project 1710, "Training, Personnel and Psychological Stress Aspects of Bioastronautics," Task 171007, "Automation of Training Systems," by the Operator Training Section, Training Research Branch, Behavioral Sciences Laboratory of the Aerospace Medical Laboratory. The compilation and cataloging were begun in July 1960 and completed in April 1961.

The authors wish to express their gratitude to all those individuals, institutions, and firms who furnished information and photographs of their devices and graciously permitted their publication. Without their cooperation this report could not have been completed.

The impetus for the present report arose from a set of photographs of auto-instructional devices collected by Capt Laurence G. Goebel, Hq Air Force Systems Command. For some time we used the photographs to brief people interested in the state of the art of auto-instruction. Ultimately, we decided that a more valuable service could be given to potential users by augmenting and cataloging the collection. Auto-instruction is a highly complex subject that demands a high degree of professional competence from its practitioners. Therefore, the information in this report probably will not be sufficient to enable potential users to launch a successful program, since precision and detail have had to bow to brevity. For completeness and accuracy of the descriptions of the different devices we were dependent on information supplied to us. Furthermore, it is probable that some important instructional devices were overlooked at the time the survey was conducted, or that some new devices have been developed since that time. However, this report may be able to help orient the reader faced with the bewildering array of speculative information that is being purveyed and to suggest possibilities for applications to local training or educational problems.

A second use of this report is envisioned for another readership. This is the professional and scientific community who is in periodic need of a record of the current state of the art. We hope that the catalog of auto-instructional devices with summary sketches of their characteristics will be of use to this group as a ready file of existing equipment.

ABSTRACT

This report summarizes the state of the art of auto-instruction and teaching devices and catalogs instructional devices to April 1961, in the interest of suggesting possible applications to local training or educational problems. The first section briefly reviews what auto-instruction is, whether it is an entirely new concept, its practical benefits, auto-instruction terminology, programs and devices, current programming formats, evaluating a program, and discusses prospects for the future of auto-instruction. The second section catalogs and describes all major current auto-instructional devices: Skinner machines, Pressey machines, Crowder technique, self-organizing systems, audio-visual machines, digital computers as teaching machines, and miscellaneous devices. A list of teaching machine patents is appended.

PUBLICATION REVIEW

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SECTION I

AN OVERVIEW OF AUTO-INSTRUCTION

What is Auto-Instruction?

The technique which here has been called "Auto-Instruction" is currently gaining increasing prominence in educational practice and is also often labeled with other terms. "Teaching machines," "automated training," "programmed learning," "self-tutoring" are but some of the terms that have been used to refer to it. "Auto-instruction" has been suggested by D. J. Klaus and A. A. Lumsdaine because it avoids the misleading emphasis on devices which is present in "teaching machines" and because it reflects simultaneously the self-instructional character of the approach and the automation which is invariably present. It is the usage which will be followed in the present report.

At this time it would be exceedingly difficult, if not impossible, to give a definition of auto-instruction that would be agreeable to its various proponents and supporters. Perhaps the best that can be done is to provide a broad characterization that may entail a minimum amount of disagreement. Even so, one immediately encounters two perspectives. One might be called the scientifically oriented, or "nothing but" point of view; the other reflects a practical, or "more than" outlook. The former orientation is the one chiefly adopted by behavioral scientists, while the latter is held mostly by educational practitioners. Both views have merit.

From the scientific, reductionist point of view auto-instruction is nothing but an application of the principles governing the interaction between the teaching presentation and the learning individual. It is, however, a minutely systematic application of the scientific principles of learning; and the application itself is guided by the general principles of engineering-design logic. It strives to select the optimal values for those parameters of the learning situation that facilitate learning and favor later proficient performance in a criterion (application) situation.

For the practicing educator auto-instruction represents a true automation of instruction. Like any true automation it involves more than a mere mechanization of the instructional process; to borrow from the engineer's language--it involves a closed loop with feedback control over the learning process. Indeed, this is the basis on which a distinction has been proposed between training aids and teaching machines. In the closed loop, information flows not only from the instructor to the student, but also from the student to the instructor. That is, explicit and detailed provisions are made to give cues to the instructor concerning the degree of success that the student is having in his learning endeavor so that he may adjust his teaching presentation accordingly. Of course, to some extent the classroom teaching situation, too, involves a closed loop; but the information being fed back is scant, somewhat unreliable, and not very specific. Auto-instruction is adaptive instruction in which the instructional presentation is adjusted to the limits of practical feasibility by the student's "error output," in other words, by the evidence of his misconceptions and inadequate mastery of some important aspect of the instruction. The explicit recognition of the closed-loop principle has two major corollaries. The instructional presentation is aimed at the individual student instead of at a relatively undifferentiated group as in the ordinary classroom or a closed-circuit television presentation. Thus conditions are analogous to a private tutor instructing a single student. As a second corollary the student interacts directly with the instructional information. The person, but not the function, of the instructor is eliminated so that one step in the transmission of the instructional information (and a major source of noise, or confusion) is removed. Another important characteristic of auto-instruction is that it provides for a continual, step-by-step testing of the proficiency being attained by the learner. Therefore, the successful completion of a set of auto-instructional materials guarantees that some specifiable level of proficiency has been reached--at least for the moment. Instruction ceases only when the desired level of mastery has been reached. Thus auto-instruction compensates for some of the less desirable consequences resulting from differences among students. Whereas conventional forms of instruction proceed for some given length of time and produce a wide range of attained proficiencies, auto-instruction tends to require varying durations for its completion but will produce a very narrow range of student proficiency. This means, of course, that the intellectually gifted individual can proceed at his own rapid pace while the less gifted individual can master the material at a slower pace and without being bested continually.

Is Auto-Instruction an Entirely New Concept?

It has been said that nothing under the sun is ever altogether new. The roots of auto-instruction reach into several areas that are well established and have been with us for a long time. The first member of this ancestry is the mental testing field, particularly the achievement testing area. Another line of descent traces back to the field of audio-visual instruction. Relations also exist with principles and practices governing the use of training aids and devices. The most recent impetus, however, has come from the scientific laboratories devoted to the study of human learning.

The significant novelty of auto-instruction derives primarily from the systematic application of learning principles. This statement must be regarded in much the same light as the statement that the jet engine is merely an application of the venturi-tube principle. Auto-instruction, while it employs many of the trappings of familiar forms of instruction, permits a degree of control over, and guidance of, the learning process that has been possible hitherto only in the confines of the learning laboratory.

Practical Benefits

The auto-instructional technique promises a number of practical benefits. The degree to which these benefits may be realized at present corresponds exactly to the degree to which ideal auto-instructional conditions have been actually established.* For example, it is a moot point whether presently feasible auto-instruction is better or worse than a good instructor. It is almost certainly better than a poor instructor, and it may be better than even a good instructor on a day on which he is not at his best. Benefits for practical training operations may be roughly divided into three categories that have been arbitrarily labeled efficiency, economy, and flexibility of operation.

Efficiency

Because the conditions under which learning takes place are continually adjusted to suit the learner, the efficiency of auto-instruction is potentially limited only by him. The learner's (student's) internal conditions (eg, he may be sleepy, tired, inattentive) are the only ones beyond the control of the determining situational factors. All instruction is based on a painstaking analysis of the performance that ultimately will be demanded of the learner, whether that might be the solution of mathematical problems, trouble location in an electronic circuit, or the steering of some space vehicle. For this reason, the likelihood of a complete and thorough coverage of component skills and knowledges is extremely great. Since instruction continues until the requisite proficiency has actually been demonstrated, there is an assurance that students will be neither overtrained nor undertrained. The graduates of auto-instruction will have quite uniform and, therefore, predictable proficiency. Compared to graduates of conventional instruction, the quality of their performance will tend to be far less variable. Hence, much greater reliance may be placed on them to perform as required in the military or industrial setting.

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*Present reality most often represents some approximation to complete auto-instruction. However, current research and development programs are making closer and closer approximations possible.

Economy

The automated character of this form of instruction reduces the number of people who are needed except in very small instructional programs. Because materials are centrally prepared, only a relatively small group of highly competent instructors (or programmers as they are called) is required. Those persons, who may be needed in the classroom because absolute automation has not yet been fully achieved, function as proctors rather than instructors in the conventional sense. Teaching machines can be made to be exceedingly sensitive, infinitely patient, and of course they never tire. They can work around the clock. Generally they require only a one-time investment and demand no continuing payments of salary after that. Admittedly this investment may be large in terms of the absolute amount of money needed; however, if the total number of students to be trained is large enough, the cost per student becomes relatively small and continues to diminish as the total number of graduates increases.

Flexibility of Operation

Under many circumstances it is important to be able to offer large training or educational programs on short notice. Auto-instructional materials are usually prepared in a single central location making it possible to stockpile them against anticipated or even unanticipated demand. When such a demand occurs, the physical materials can be easily duplicated and readily distributed to widely scattered locations. Also, since the master copy is held in a central location, revisions can be made quickly and easily.

Auto-Instructional Terminology

For better or worse, a technical jargon has grown up with auto-instruction. Although terms have not been standardized, there seems to be considerable agreement on their usage. A familiarity with the major terms is essential for any discussion of the field.

It is customary to refer to the set of materials that contain the actual instruction as the "program" (an extension of the basic meaning of program in the terminology of digital computation). It refers to the planned arrangement and pre-ordering of the controlling events that guide the student's learning efforts. The process of arranging subject-matter (eg, electronics, spelling, Russian) into a program is known as "programming," and the person so engaged is known as the "programmer." The programmer, who is a specialist in the design of instruction, usually works in cooperation with the "subject-matter expert." The latter is simply a person having special knowledge of the subject in which instruction is being prepared.

Programs may be either "linear" or "branching." A linear program is one in which all students encounter exactly the same material. In a branching program some students may be guided into special sequences, usually of a minutely explanatory nature, before being guided back to the main sequence. Program sequences are composed of "frames" which are also called "items," "pages," or "images." Each frame should contain a "stimulus" which is a bit of instructional information that is expected to elicit from the student some part or some approximation of the "terminal behavior," or mastery of the subject-matter. Each frame also demands a "response," i. e., a demonstration of the required mastery. Responses may be of the "active recall" variety in which a "free" response is "constructed," or they may be of the "recognition" type in which the student selects one from among a "multiple choice" of possibilities that are offered to him. Responses may be "prompted," i. e., supplied before the student has had an opportunity to make them himself. A distinction has been proposed between "prompts" in which the complete required response is furnished and "cues" in which only hints, partial response information, are given.

Programs and Devices

One argument for rejecting the term "teaching machines" in favor of "auto-instruction" is founded on the undue emphasis that the former designation places on the physical implements of this approach. The foregoing shows that programming is the core of auto-instruction. It is the programming of the instructional information that guides the learning process and produces the characteristics that were outlined above. Machines or devices without programs in them are nothing more than an assemblage of hardware. No instructional characteristics can possibly be ascribed to them.

Devices are merely the tools that translate the scheme of programming into reality; often they are no more than conveniences that turn the pages for the student or automatically time the presentation for the instructor. The characteristics of the particular programming scheme being employed serve as the design criteria for any device and, similarly, serve as the primary criteria for its evaluation. The excellence with which the programming demands are fulfilled, the reliability of the mechanism, its cost, and its flexibility (adaptability to various programming formats) can be the only consideration in assessing any device's value. Thus the second section of this report should be regarded only as a listing of existing tools and should not be thought to reflect any judgment about their worth.

Current Programming Formats*

At some time in the future we may arrive at a complete, experimentally tested and verified set of principles of programming. Such a set of objective principles will leave little room for subjective opinions and personal style. However, this report is intended as a record of present reality; and present reality is still far from perfection. Three, or possibly four, major schools of thought exist at this time, each of which favors a distinguishably different programming format. Programmers adhering to each style have produced an amazing number of variations on each basic theme; but, except in a very few cases, the basic theme does remain distinguishable. Each of the major formats are associated with the name of the individual who originated it. Programming formats will be listed and discussed here on that basis.

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*For a more detailed discussion of program formats the reader is directed to a parallel publication which surveys current programming and catalogs existing programs. See Rigney, J. W. and E. B. Fry, A Survey and Analysis of Current Teaching Machine Programs and Programming, Audio Visual Communication Review, 1961, 9, Supplement No. 3.

Pressey's Format

Sidney L. Pressey was the first man to propose auto-instruction. He developed this idea through concern with achievement testing. In his first publication in 1926, which appeared in School and Society, he spoke of "A Simple Apparatus Which Gives Tests and Scores--and Teaches." Pressey decided that the ordinary achievement test item could serve the dual purpose of conveying instructional information as well as discriminating whether that bit of information had been mastered. These origins are reflected in Pressey' s programming format. Each frame of his programs consists of a questioning statement and a choice of several possible answers.

At the simplest level the student merely choses an answer for each question and is then immediately informed whether his choice was right or wrong. He proceeds through the entire set of items or frames for as many times as may be required until each and every item has been answered correctly at least once. Pressey's programming is probably the least specifically defined of the several schools. There are no objections to employing error scores as determiners for sending the student into branching sequences. Pressey is noncommittal or favorably disposed toward prompting, low item difficulty, removal of items that have been answered correctly (so they will not be reencountered), and so forth. He does agree with all other schools that immediate information to the student about the correctness-incorrectness of his response or immediate reward for correct responses is absolutely essential.

Skinner's Format

B. F. Skinner, after devoting many years to the study of basic behavioral science, turned to education and is primarily responsible for demonstrating the feasibility and practicality of auto-instruction. Much of his time was spent in investigating the laws of operant conditioning as reflected in the behavior of white rats and pigeons who served as laboratory animals. When Skinner began to extrapolate these learning principles to verbal behavior, it occurred to him that verbal or symbolic learning (i.e., learning characteristic of human beings in a training or educational situation) could be made far more efficient as well as effective, if it were guided with the same precise control that is exercised in the animal learning laboratory. The origins of the principles underlying Skinner's programming should not be taken as an excuse for disregarding them or depreciating their merit, since Skinner and some of his followers have successfully shown that they can cope in this way with highly complex concepts involving what has been called traditionally the "higher thought processes."

Skinner insists first of all on the free, constructed response. His frames consist of statements with one or more of the key words missing, and the student is required to fill in the blank spaces. Skinner insists that they actually write the missing words. Program sequences begin with relatively innocuous statements that require responses the student most probably can make. Succeeding frames are so designed that, in Socratic fashion, they lead the student to pursue the complete implications of the knowledge that he already possesses. For Skinner, the ideal program is one in which a student proceeding from the first to the last frame does not make a single incorrect response. Notice that, if he were to proceed in the reverse direction, this would not be so; ergo, the procedure is not trivial, since as a result of it the student knows things or can do things that he did not know or that he could not do at the outset. To accomplish this feat adjoining frames must of necessity comprise small "steps." Unfortunately a "step" is an ill-defined term but seems to mean that only a very tiny amount of new instructional information has been added. The student must never be allowed to make a successful (uncorrected) incorrect response. Normally this is precluded because as soon as any response has been made the student is provided a correct answer with which to compare his own. However if one were to prepare a program designed to teach typewriting, for example, provisions would have to be made to lock the keyboard except for the sole key whose depression would constitute the correct response at the moment.

It is beyond the scope of the present discussion to pursue even the major Skinnerian learning principles (eg, "shaping" behavior), which are highly relevant to his programming. A comprehensive treatment of these matters will be found in a forthcoming Handbook of Instructional Programming.* In auto-instruction one need not be immediately concerned with the question of whether the student enjoys the learning process. Indeed, he may find it extremely wearisome to complete a program composed of very small steps. The sole measure of the program's adequacy is whether the student can do what he could not do before. The problem of motivating the student can be viewed as a separate and secondary one, although Skinner insists that the ideal program is simultaneously instructive and enjoyable. He claims that the reinforcement schedule (pattern of correct responses) in a good program makes it necessarily acceptable to the student, but he has presented no evidence in support of this claim.

Crowder's Format

The path which led Norman A. Crowder to auto-instruction began in mental test construction and factor analysis. It continued through a period of preoccupation with the measurement of proficiency possessed by electronic technicians and ultimately with the problem of creating proficiency in malfunction diagnoses (trouble-shooting). The diagnosis of malfunctions in electronic circuitry is fundamentally a process of sequential decision making in which a single, most efficient sequence can be designated. Although any disclosure resulting from a departure from the most efficient sequence does not provide much information in the formal sense and is considered largely redundant, it is also obviously helpful to a student. This observation contains the germ of Crowder's programming format.

"Intrinsic programming" as it is called, because the exact program sequence is determined by factors that are intrinsic to the particular student and the particular learning situation, employs the strategem of the "scrambled book." On page one of the book or on the first frame of microfilm, the student is introduced to the topic with a short informational paragraph. A key question follows the paragraph and a choice of several possible answers. Each answer choice is indexed to a page number or to an image number if microfilm is being used. While the sequence of page numbers in the scrambled book is in normal order, there is no topical continuity from page to page. Only after the student turns to the page number corresponding to his answer choice does he find there a continuation of the topical material. Assuming that his choice was incorrect, he will find on that page in the following order: (a) a recapitulation of his answer choice, (b) a statement that this answer is incorrect, (c) a brief paragraph reviewing the presumable faulty reasoning that led to this answer choice together with corrective information, and (d) directions to return to the first page. If it can be assumed that on his second attempt the student makes a correct choice of answers, he will find on the corresponding page the main continuation of the topical material. There will be (a) a recapitulation of the answer choice, (b) a statement that this answer is correct, (c) a review of the reasoning that leads to the correct answer, (d) an extrapolation of this reasoning, which introduces new information, (e) a key question about the new material, and (f) a choice of several possible answers with a new set of corresponding page numbers.

Crowder's programming has undergone a number of refinements,such as the introduction of test-sequences that automatically determine the amount of review into which the student is guided. His programming is heavily dependent on clear exposition and succinct style. An emergent principle seems to be that the main sequence, i.e., that composed of the correct answer choices, should be as brief and concise as possible and that all ancillary information should be stored in the branches.

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*To be published by the Aerospace Medical Laboratory.

Pask's Format

It is extremely doubtful whether one can properly speak of a programming format in connection with Gordon Pask. He is a cybernetician who applies the principles of both cybernetics and mathematical "game theory" to the teaching situation. He regards that situation as having "self-organizing" properties, i.e., being capable of developing a set of conditions that correspond to some desired state of affairs.

According to Pask,the instructor (usually a black box) and the student are engaged in a "partially competitive and partially cooperative game." The competition aspect of the game derives from the fact that the instructor tries to present the student with the most difficult problem to maximize his (its) own gains. The cooperative aspect results from the instructor' s aim of making the student proficient and the student's desire to become proficient. The game is so devised for each particular application that it tends to lead toward the desired final (proficient) state of affairs. The final state is any "move" (question) of the instructor countered (answered) successfully by the student. The "pay-off function" is so adjusted that the best move at any moment (the one leading most directly to the final state of affairs) receives the maximum possible pay-off.

Pask's programming is fundamentally unconcerned with human learning principles and assumes no learning theory. It is achieved by restricting the conditions surrounding the learning-teaching situation in such a way that only one narrowly defined range of rational behavior is possible which presumably guides the course of learning. Neither the validity of the assumptions underlying Pask's approach nor its efficiency have been tested so far.

Evaluating a Program

Earlier, we discussed considerations that should enter into the evaluation of any auto-instructional device. A parallel question arises about the criteria by which a particular auto-instructional program should be assayed. At the beginning of the preceding section we said that some time in the future we may arrive at a complete, experimentally tested and verified set of principles of programming. Since such a set of principles does not yet exist, there is no absolute criterion for choice on the basis of programming format. In fact, the only defensible criterion lies in the answer to the question of whether the program teaches. More specifically, the question should be divided as follows:

1. What level of proficiency can be expected, and how reliably may it be expected?
2. What was the population (composition of group) for which the efficacy of the program was demonstrated?
3. How much time is required to achieve the specified level of proficiency?
4. What is the cost per student-hour?

In all cases, whether selecting among programming formats or whether selecting a particular program, the opportunities afforded by a product improvement program should be considered. This can be achieved in two ways: first, virtually all forms of programming automatically accumulate data about their own characteristics. Hence, it is possible to revise program sequences with relatively little effort so as to enhance desirable characteristics and minimize undesirable ones. Second, for some time to come improvements in technique for all of the various programming formats may be expected. Once a subject-matter has been cast into a "raw program," it is relatively simple to add features recommended by increasing sophistication.

The Prospects for the Future

The directions in which programming as such is likely to develop have been suggested already. Undoubtedly the emphasis will remain on verbal or symbolic types of learning, but increasingly the techniques of auto-instruction will be applied also to motor skills. The second section of this report suggests more forcefully than words could the prospects for progressively more sophisticated devices and the range of programming flexibility they may provide.

Pask is currently engaged in solving the problems incidental to the design of an adaptive teaching system with a capability for self-selecting and altering the criteria for adaptation. The system is to be capable of imparting instruction in any conceptually structured subject-matter. It will, itself, sort these concepts from one or more of the categories. It will then immediately evaluate the success of its stratagems relative to an optimal strategy and, if less than optimally effective, shift and readjust its instructional presentation.

Digital computers may be expected to play an increasingly larger role in auto-instruction. Their function will be to serve as the data-processing and decision-making core of highly sophisticated auto-instructional systems. In such a system, multiple facets of each student's response to each successive item will be measured. The immense storage and data-processing capacity of modern digital computers makes it possible to accumulate, collate, and continually reevaluate all of this information. The outcome of the evaluation can provide the basis for selecting among the many possibilities stored in the auto-instructional system the most appropriate next item for presentation to each student. If the computer programming (as opposed to auto-instructional programming) problems can be worked out, systems that simultaneously instruct between 300 and 400 students at a cost of no more than one dollar per student hour appear feasible.

At a lesser level of technological complexity, it is highly probable that research directed toward the use of words, the use of pictorial and diagrammatic material, and the arrangement of the simple printed page will produce substantial gains in auto-instructional effectiveness. For, although computers and self-organizing systems can perform near miracles in the way they turn pages, how they sort statements, and how they add or eliminate them, it is ultimately the printed page itself with which the student must cope if he is to assimilate the instructional information.

Recommended Readings

Galanter, E. (Editor), Automatic Teaching: The State of the Art, John Wiley and Sons, New York, 1959.

Lumsdaine, A. A., and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, Department of Audio-Visual Instruction, National Education Association of the United States, Washington, D. C., 1960.

Stolurow, L. M., Teaching by Machine, U. S. Office of Education Cooperative Research Project Monograph, Washington, D. C., Government Printing Office, 1961.

SECTION II

CATALOG OF AUTO-INSTRUCTIONAL DEVICES

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GENERAL

The information in this section was obtained by sending questionnaires and requests for photos or drawings to all individuals and organizations known to the authors as having an interest in auto-instruction. It will be obvious that this procedure immediately entails three sources of error. First, our knowledge of parties in possession of teaching machine information may have been incomplete. Second, not all recipients of questionnaires returned them by the deadline we had to establish. Third, not all respondents provided all of the information that had been requested.

Information set forth in this catalog is largely as it has been represented by respondents to our questionnaire. In some cases it already may be obsolete. Prices cited have been rounded off. Prices, and in certain instances data about physical characteristics, are given only to provide information about order of magnitude; they cannot be relied upon to be accurate. Originators have been identified wherever this has been possible. When the individual originators were unknown, a corporate originator was listed. Addresses for originators are not necessarily current.

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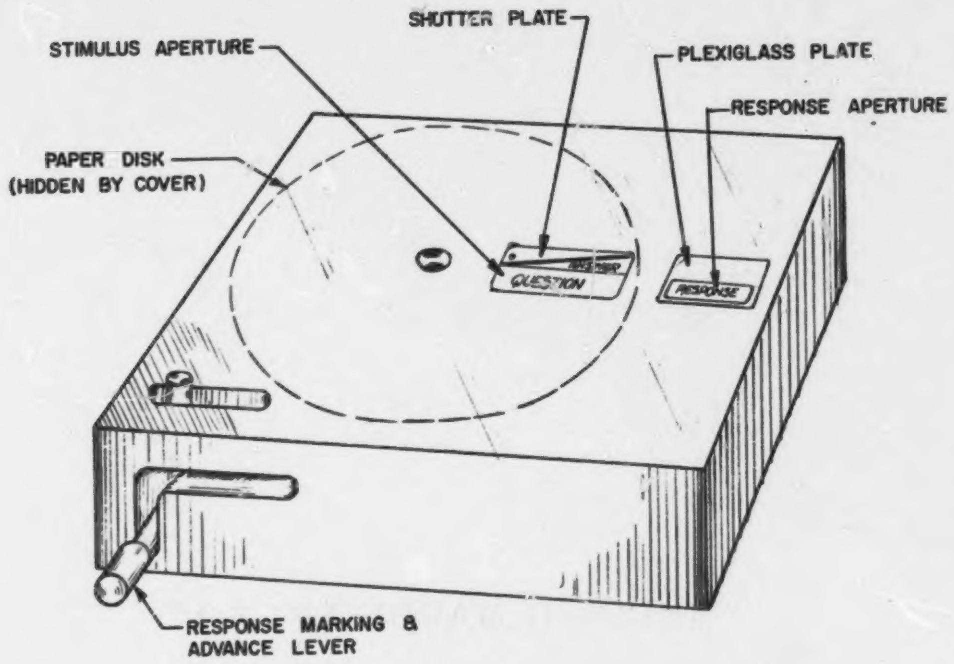
SKINNER MACHINES


SHUTTER PLATE
STIMULUS APERTURE
PLEXIGLASS PLATE
RESPONSE APERTURE
PAPER DISK
(HIDDEN BY COVER)
ANSWER
QUESTION
RESPONSE
RESPONSE MARKING &
ADVANCE LEVER

DISK MACHINE

Date: 1954

Source: Not commercially available

Cost: Unknown

Originator:
B. F. Skinner
Harvard University
Cambridge, Mass.

History: Developed by B. F. Skinner for instructing mature students in subject matters involving relatively complex concepts and verbiage. The design embodies the functional characteristics essential to programming the instructional material in accordance with the principles which Prof. Skinner regards as governing "...the acquisition and maintenance of verbal behavior..." The disk machine is the prototype of a family of commercial and noncommercial devices all of which are designed to support a Skinnerian type of programming.

Operation: A sequence of open-ended statements is printed in 30 radial segments (frames) on a 12-inch paper disk, and the disk is fitted into the machine. The student must lock the machine and, once started, it cannot be unlocked. With the cover in place all but the corner of the first statement (frame) appears in the left (stimulus) aperture. The correct answer is also printed on the disk slightly above the question, but hidden by the shutter plate. The student writes his response on a paper strip (adding-machine tape) under the right (response) aperture. By lifting the lever on the front of the machine, he moves what he has written under the plexiglass plate and simultaneously retracts the shutter plate under the left (stimulus) aperture revealing the proper response. If the two responses correspond, he moves the lever horizontally. This punches a hole in the paper opposite his response, recording the fact that the response was correct, and alters the machine so that this item will not reappear when he works around the disk a second time. The next disk segment (frame) appears when the lever is returned to the starting position. The student proceeds in this way until he has responded to all of the 30 frames. He then works the disk a second time, but only those frames appear to which he has not correctly responded. When the disk revolves without stopping, the lesson is finished.

Uses: Can be used for instructing reasonably mature and cooperative students in those aspects of any subject matter that can be reduced to a series of open-ended statements. Note that use of pictorial or schematic representations is not possible. Similarly it is not possible to present instructional information auditorily.

Physical Characteristics: Width: 8-1/2 inches; Depth: 11 inches; Height: 10 inches; Weight: approximately 10 pounds; Power Requirements: None.

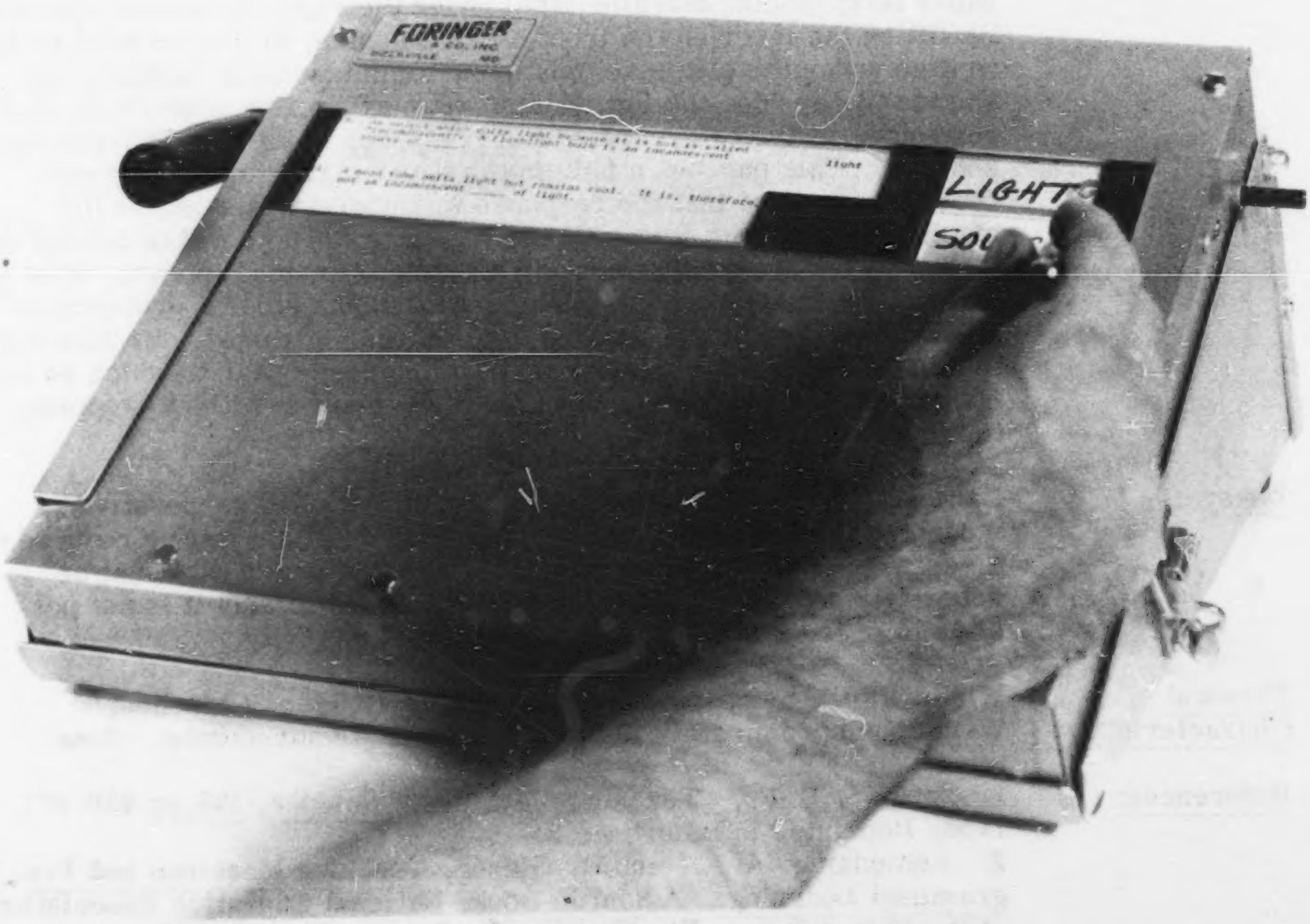
References:
1. Skinner, B. F., "Teaching Machines," Science, 128, pp 969-977, 1958, Reprinted in Reference 2.
2. Lumsdaine, A. A., and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 137-158, 1960.

FORINGER TEACHING MACHINE NO. 2002

Date: 1959

Cost: $80.00

Source:	Foringer and Co., Inc. 312 Maple Drive Rockville, Maryland
Originator:	Foringer and Co.
Description:	Functional characteristics of this device are very similar to Skinner's Disk Machine, although it has no "drop-out" feature. Instructional material is prepared on continuous strips of paper such as are used in teletype machines. Therefore multiple reproduction of instructional material with existing reproduction equipment is difficult.
Physical Characteristics:	Weight: 6-1/2 pounds; Width: 15 inches; Depth: 13 inches; Height: 6-1/2 inches
Power Requirements:	None.
Reference:	None.



DIDAK 501 AUTOMATED INSTRUCTION DEVICE

Date: 1959-60

Cost: $157.00

Source:
Rheem Califone Corporation
1020 North La Brea Avenue
Hollywood 38, California

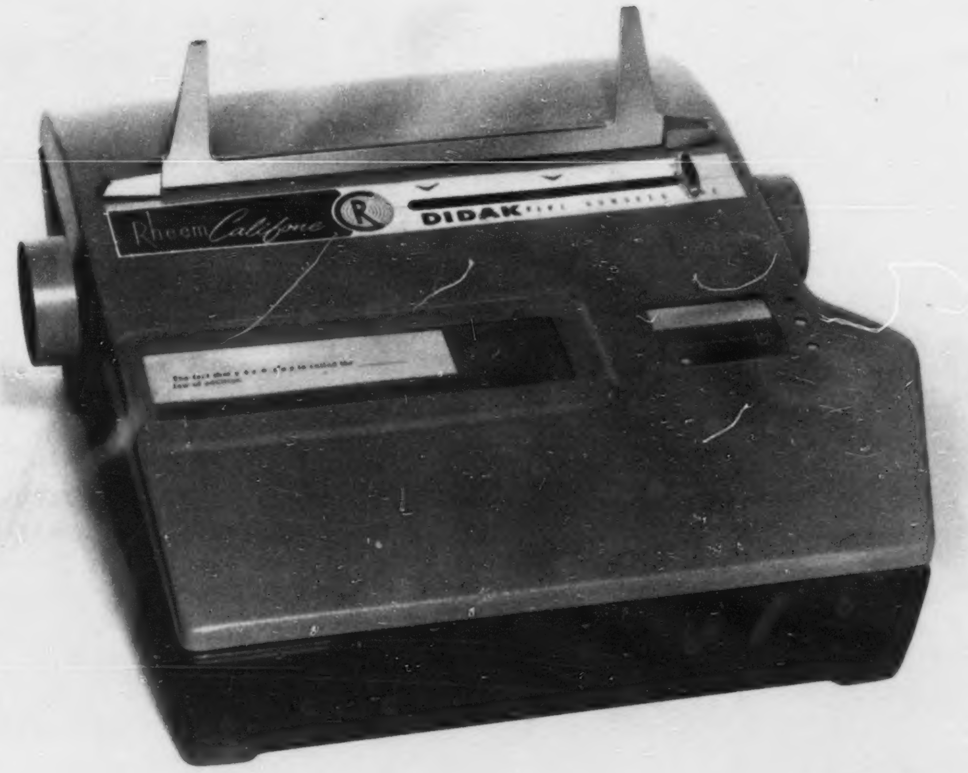
Originator: Rheem Califone Corporation

Description: The Didak differs from Skinner' s Disk Machine in that it provides a cue shutter for prompting or teaching additional information. This device also has provisions for individual tally of scores, but there is no "drop out" feature. The instructional material is presented on a roll of paper, rather than a paper disk. Multiple reproduction of program material is difficult because nonstandard techniques are involved. In all other aspects, the two devices are almost identical.

Physical Characteristics: Weight: 15 pounds; Width: 13-1/2 inches; Depth: 17 inches; Height: 6 inches.

Power Requirements: None.

Reference: None.



AUTO-SCANNER

Date:	1960
Cost:	Unknown

Source: Not commercially available.

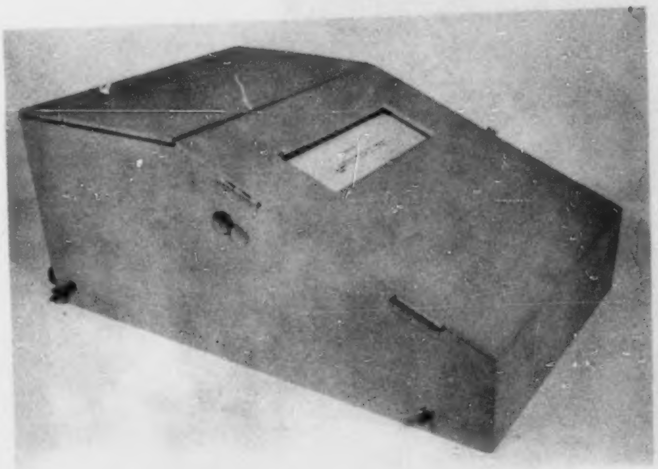
Originator:
A. Ugelow
Behavioral Sciences Laboratory
Aerospace Medical Laboratory
Aeronautical Systems Division
Weight-Patterson Air Force Base, Ohio

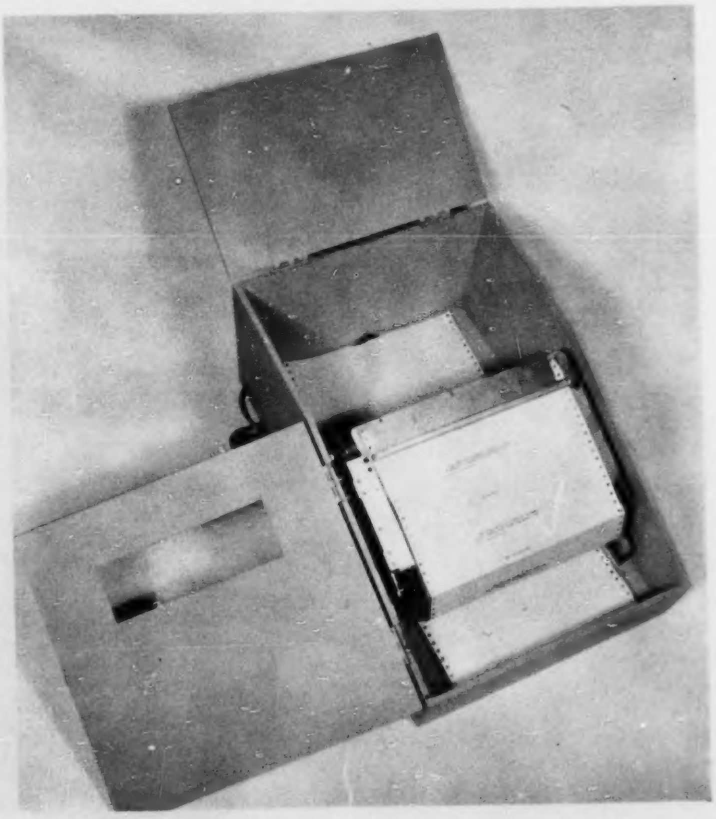
Description: This device employs a motor-driven presentation of program materials prepared on teletype paper. The student centers each frame in the window of the device by means of a forward-reverse power switch. He may enter his response to each appropriate frame directly in the window. Further advance of the program roll reveals the appropriate response. While similar in general respects to the Skinner device and others of this class, the Auto-Scanner device also permits the student to re-inspect previously encountered frames.

Physical Characteristics: Weight: 15 pounds; Width: 15-3/4 inches; Depth: 24 inches; Height: 9-1/2 inches.

Power Requirements: 115 volt ac, 60 cycle.

Reference: None.





PORTER DEVICE

Date: 1957

Cost: $80. 00

Source:
Foringer and Co., Inc.
312 Maple Drive
Rockville, Maryland

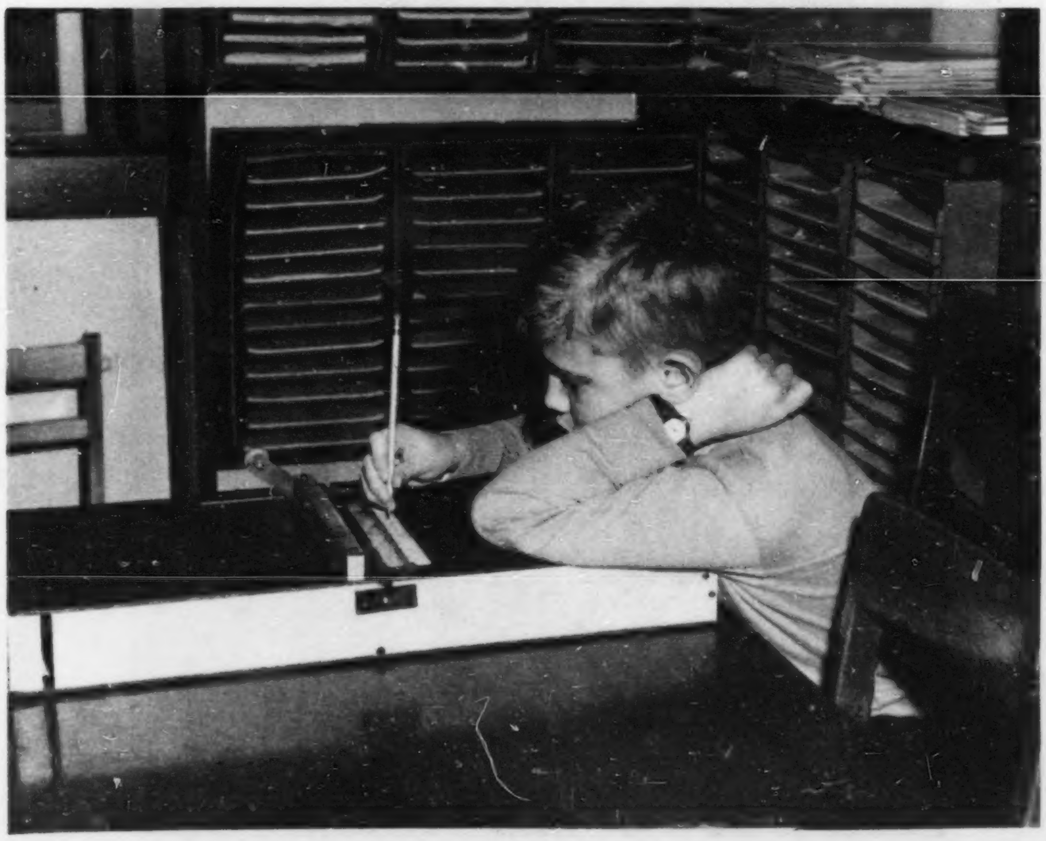
Originator:
D. Porter
Harvard University

Description: This device's functional characteristics are very similar to Skinner's Disk Machine, although it has no "drop-out" feature. Instructional materials can be mimeographed on ordinary 8-1/2 by 11-inch paper rather than requiring a special disk. Commercially available devices are redesigns of the one illustrated.

Physical Characteristics: Weight: Approximately 7 pounds; Width: 11 inches; Depth: 24 inches; Height: 3 inches.

Power Requirements: None.

References:
1. Porter, D., "Teaching Machines," Harv. Grad. Sch. Ed. Assoc. Bull., III, pp 1-5, 1958. Reprinted in Reference 2.
2. Lumsdaine, A. A., and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 206-214, 1960.
3. Porter, D. "Some Effects of Year Long Teaching Machine Instruction," Automatic Teaching: The State of the Art, E. Galanter (Editor), John Wiley and Sons, New York, Ch. 7, pp 85-90, 1959.



MIN-MAX MACHINE

Date: 1960

Cost: $20. 00

Source: Teaching Machines Inc.
235 San Pedro, N. E.
Albuquerque, New Mexico

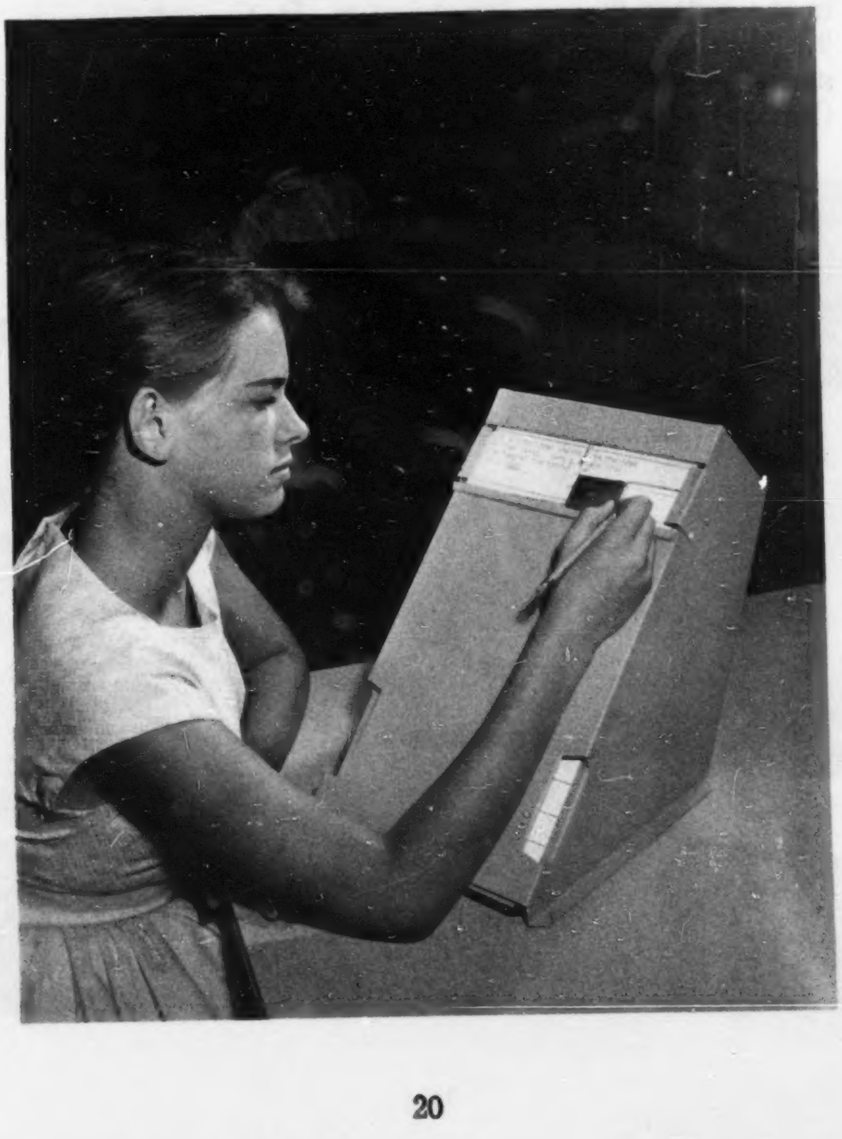
Originator: D. E. Cornell, III
Teaching Machines Inc.

Description: Basic features of the Min-Max Machine are the same as Porter' s device. Again there is no "drop-out" feature. It differs from Porter's device in the way in which the mimeographed instructional material is advanced. The student inserts the eraser of his pencil in the slot at the top of the machine and pushes the paper up. The slots at the bottom are for manual selection of the top sheet and insertion of the program materials.

Physical Characteristics: Weight: 10 pounds; Width: 10 inches; Depth: 12 inches; Height: 15 inches.

Power Requirements: None.

Reference: None.



PROGRAM SCANNER

Date: 1960

Cost: $39.50

Source:

Dyna-Slide Company
600 South Michigan Avenue
Chicago 5, Illinois

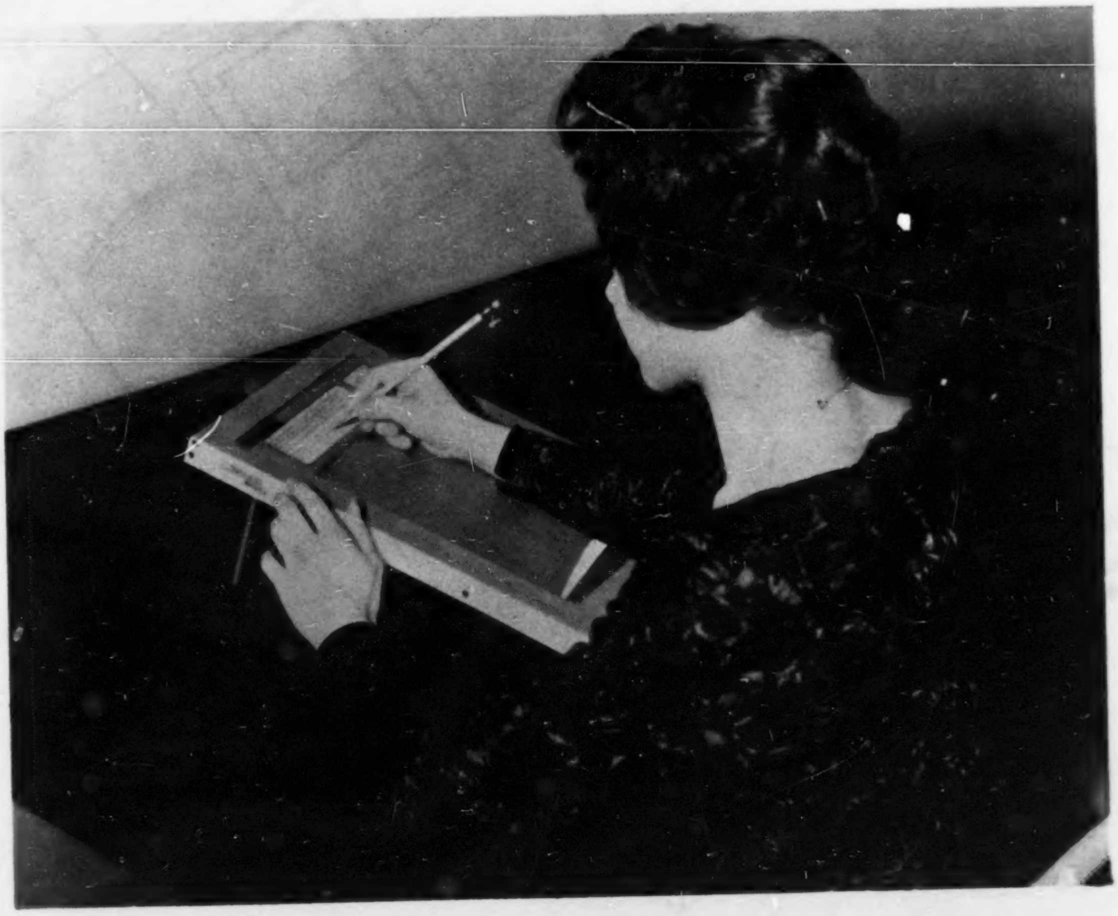
Originator: Earlham College Self-Instruction Project and Dyna-Slide Company

Operation: Instructional material is mimeographed on ordinary paper. Several successive pages are inserted into the Program Scanner and the scanning mask is raised to the top. It will now vertically scan the program as it is moved down, allowing answers to be written in at each step while keeping all other parts of the program concealed. As the scanning window is moved to the next item, the correct answer appears in the small window to the right. The answered item remains in view for comparison. Upon completion of the last step on a program page, the scanning window is returned to the top position. At this time the completed program page can be removed revealing the first step on the next program page. Analogous, but somewhat less expensive devices called "Vertimask" and "Slide-a-mask" are available from the same source.

Physical Characteristics: Width: 12 inches; Depth: 1-1/2 inches; Height: 16 inches.

Power Requirements: None.

Reference: None.



VISITUTOR CARD MODEL **Date:** 1960

Source: Hamilton Research Associates, Inc.
4 Genesee Street
New Hartford, New York

Cost: $100.00

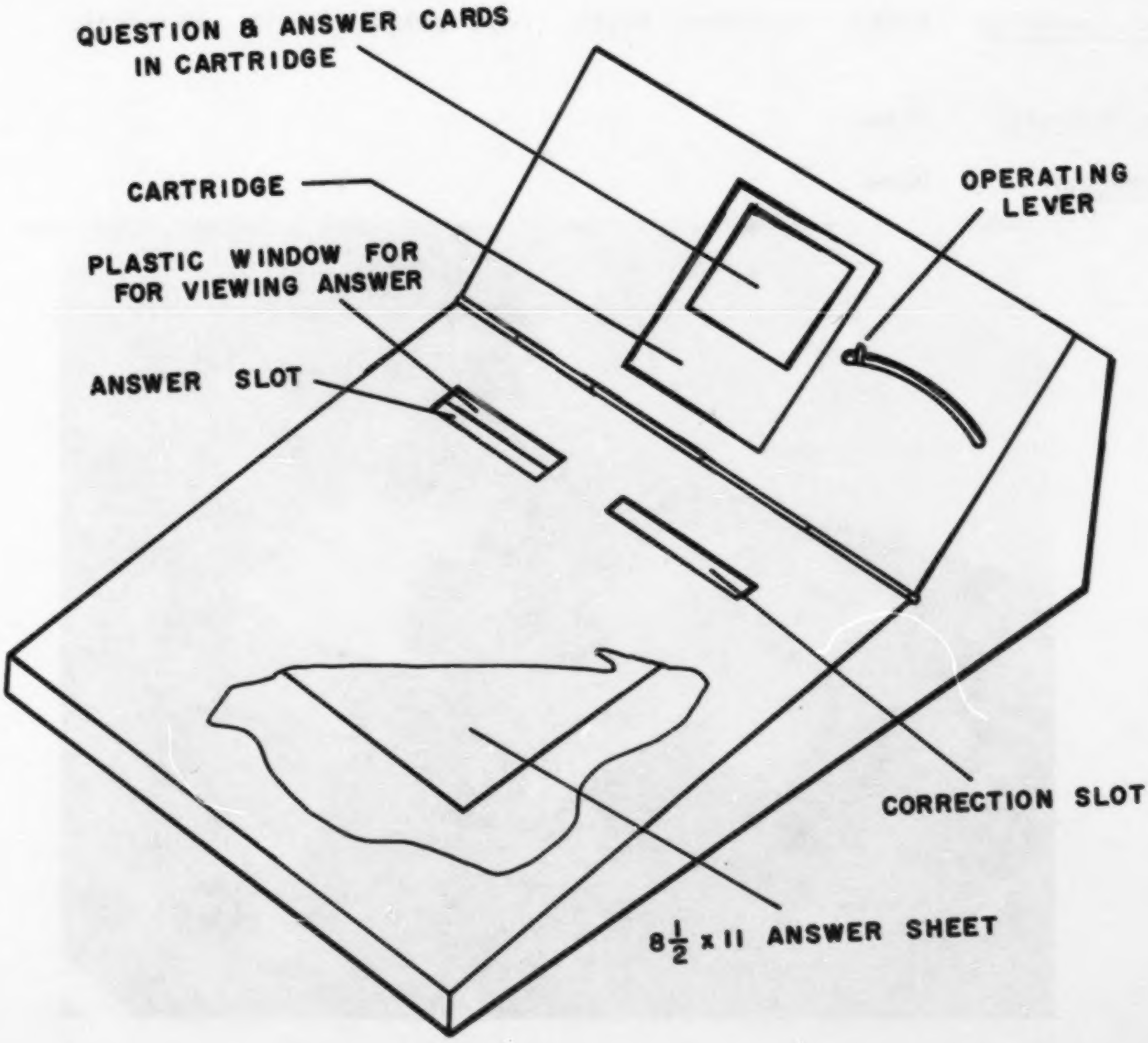
Originator: W. Rozmus, Hamilton Research Associates, Inc. and Blythe, Godcharles and Jacobson, Hamilton College, Clinton, N. Y.

Description: The Visitutor corresponds to Skinner' s Disk Machine except that the instructional material is presented on cards instead of disks, and there is a correction slot which enables the trainee to write the correct answer. This device does not possess a "drop-out" feature.

Physical Characteristics: Weight: 10 pounds; Width: 14 inches; Depth: 18-3/4 inches; Height: 6 inches.

Power Requirements: None.

Reference: None.


QUESTION & ANSWER CARDS IN CARTRIDGE
CARTRIDGE
PLASTIC WINDOW FOR FOR VIEWING ANSWER
ANSWER SLOT
OPERATING LEVER
CORRECTION SLOT
$8\frac{1}{2}$ x 11 ANSWER SHEET

MULTIPLE SENSORY STIMULATION TRAINER
(U. S. Navy Device X11H20)

Date: 1960

Cost: Unknown

Source: Not commercially available.

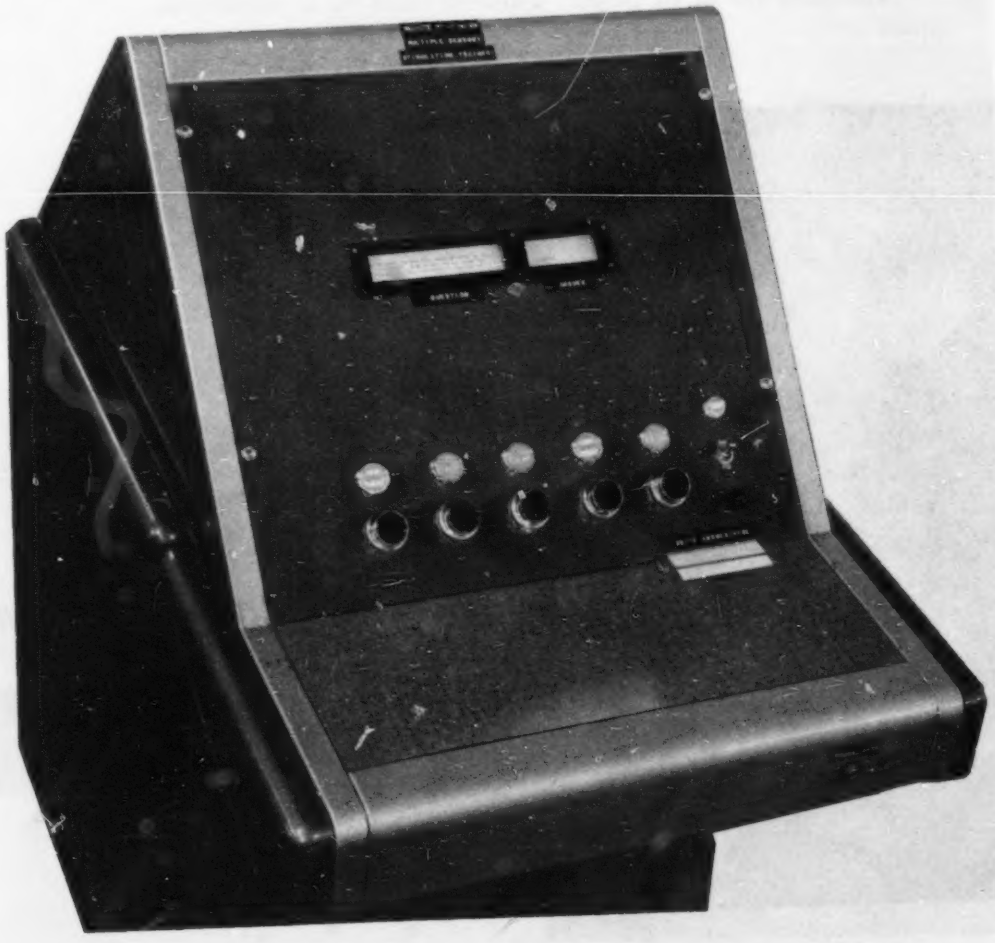
Originator: R. S. Bushnell
U. S. Naval Training Device Center
Port Washington, New York

Description: Material is presented either visually in the "question" window, or aurally by the audio tape, or both. The student constructs his response by writing it in the window provided or by reading it into the tape recorder. There is no automatic scoring feature, but immediate knowledge of results is provided by requiring the trainee to evaluate his answer against the correct answer which the machine indicates in the answer window. A new question is obtained by pressing the new question button.

Physical Characteristics: Weight: 100 pounds; Base: 21 inches by 24 inches; Height: 30 inches.

Power Requirements: 117-120 volts, 60 cycle, 6 amps.

Reference: None.



SEQUENTIAL INTEGRATED BLOCK TEACHING MACHINE

Date: 1960

Source: Not commercially available.

Cost: Unknown

Originator: J. Gilpin, et al
Bell Telephone Laboratories
Murray Hill, New Jersey

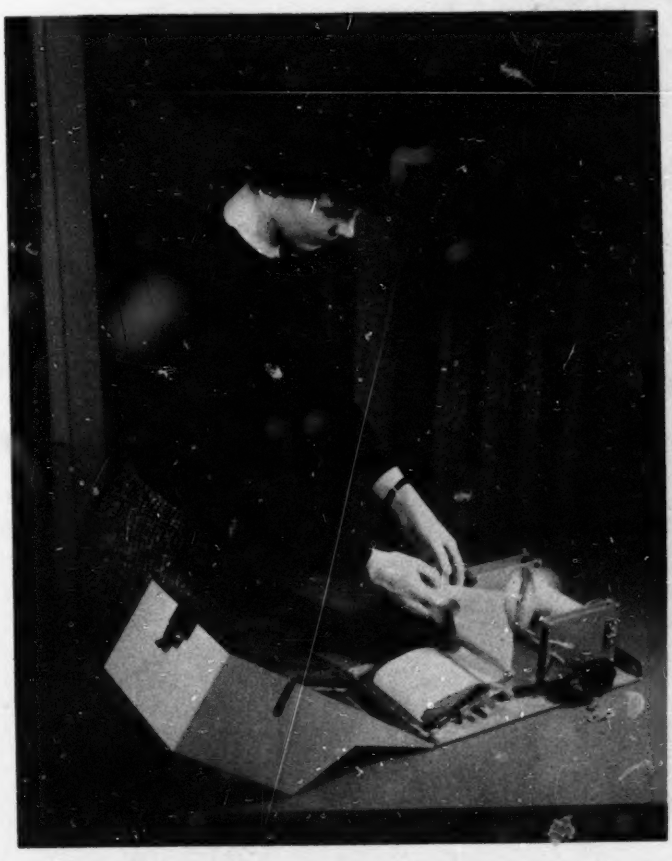
Description: In this machine, programming is achieved by moving a continuous strip of paper past a response aperture. The bulk of the instructional material is in a notebook next to the device. The question-and-answer material is located in the device and appears in the window (see picture). This device may be used in conjunction with external reference material.

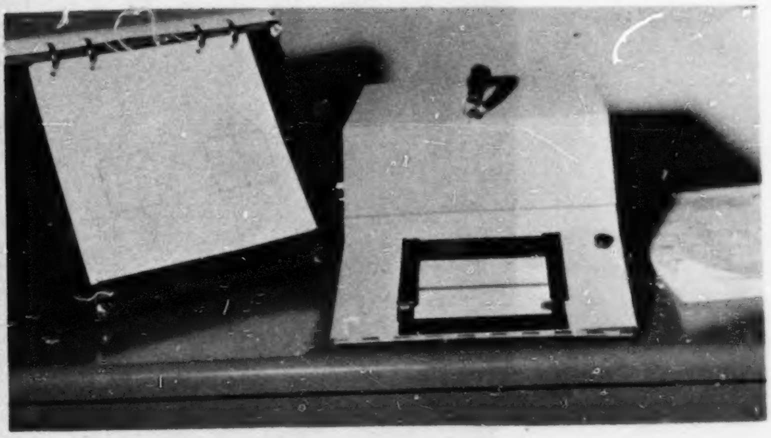
Physical Characteristics: Weight: 15 pounds; Width: 12 inches; Depth: 15 inches; Height: 6 inches.

Power Requirements: None.

Reference: None.

Remarks: Another device, very similar to the Sequential Integrated Block Teaching Machine, is the Ferster Device. The Ferster Device was conceived by C. B. Ferster, Institute of Psychiatric Research, Indiana University Medical Center, Indianapolis, Indiana. The major difference is that the bulk of the instructional material is presented in the window on a continuous strip of paper rather than in a notebook.





VISIBLE CARD FILE

Date: 1959

Cost: $1. 65 each

Source: Any stationery store

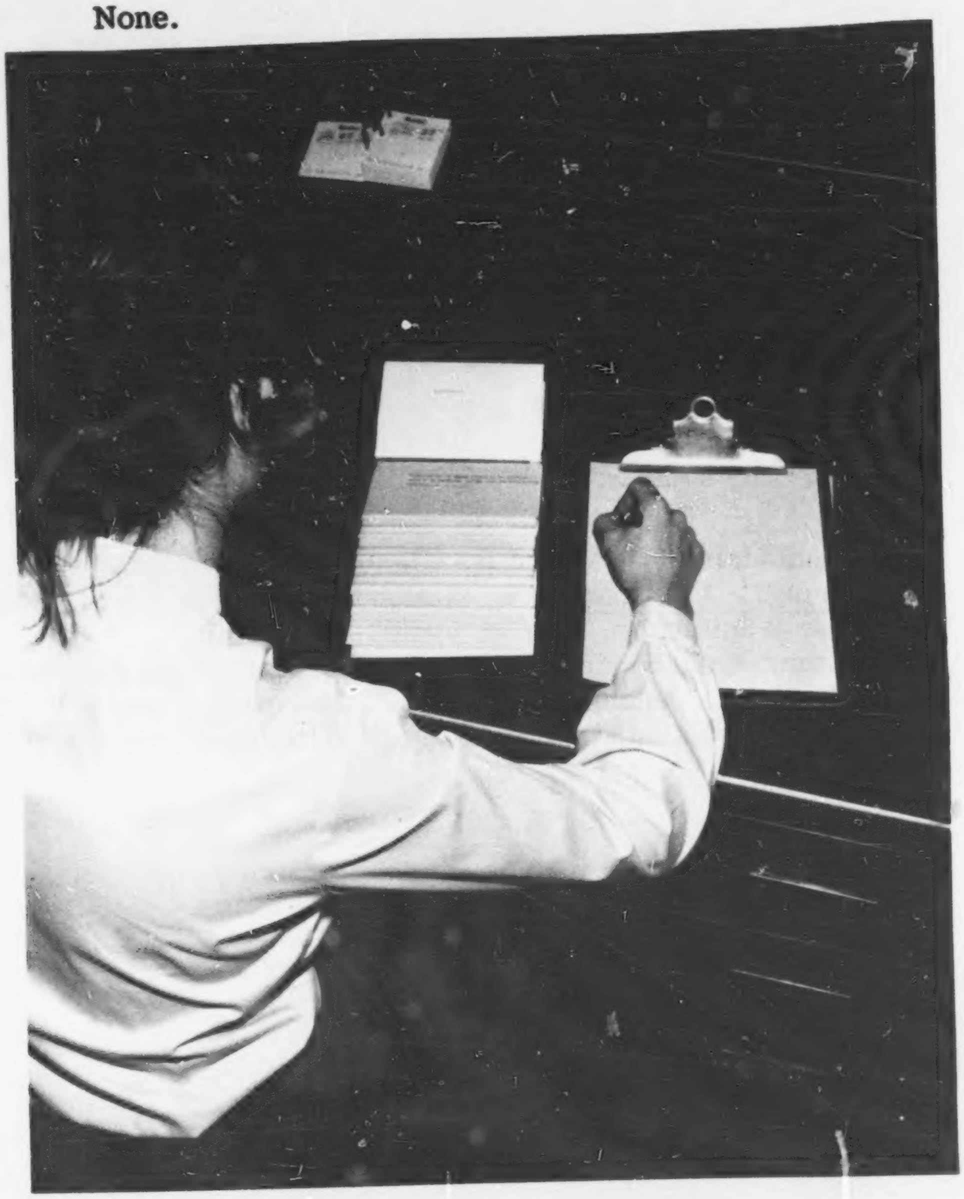
Originator: R. M. Gagne
Princeton University
Princeton, New Jersey

Description: This very simple technique requires only a clipboard and a visible card file. The trainee reads the item on the card, writes the answer in a numbered space on a mimeographed blank, flips the item card down, and reads the answer on back. There is, of course, no automatic scoring or "drop-out" feature. This file could accommodate pictorial material.

Physical Characteristics: Cards are 4 inches by 6 inches.

Power Requirements: None.

Reference: None.

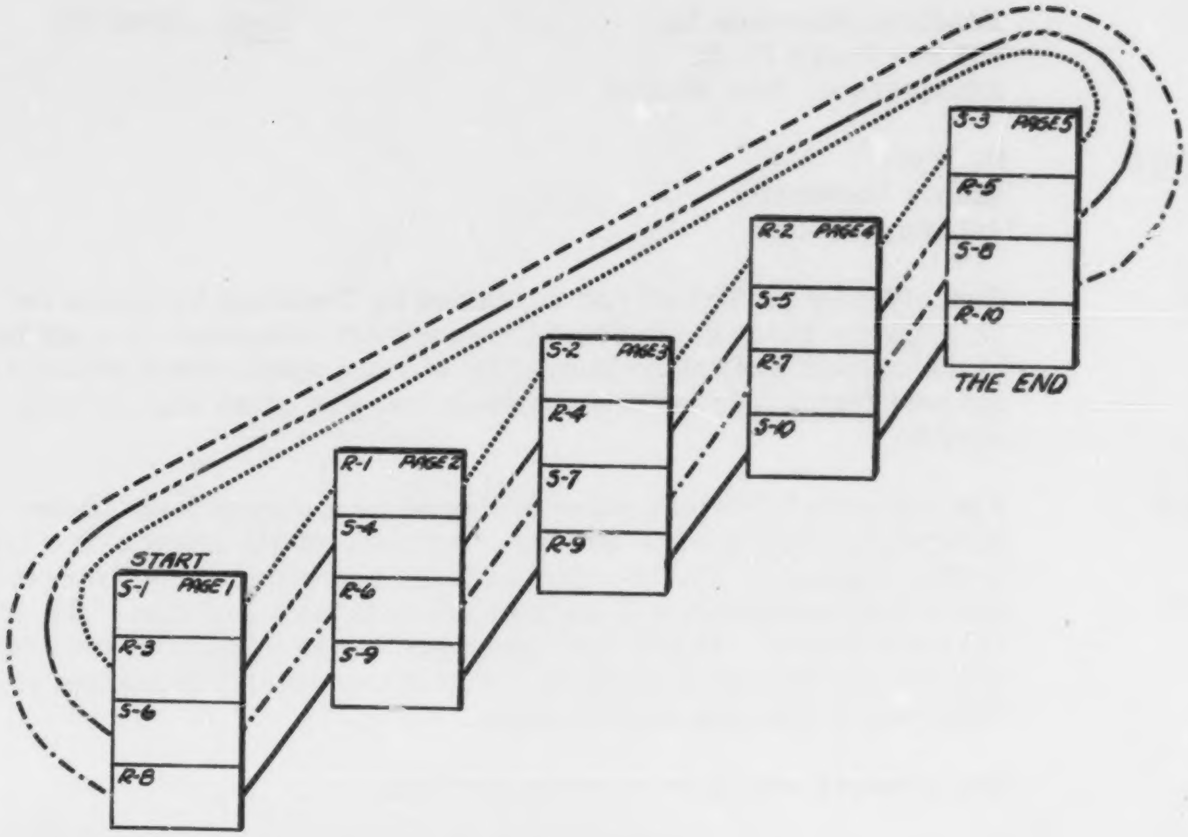


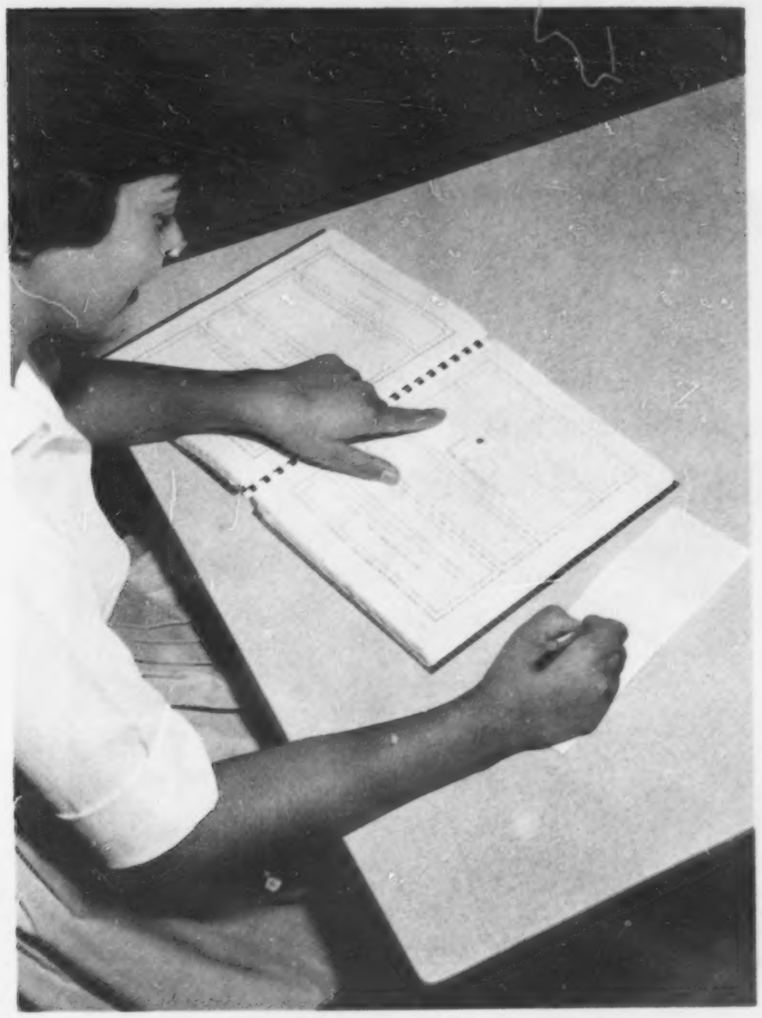
PROGRAMMED TEXT

Date: 1958

Cost: $5.00 - $15.00

Source:	Teaching Machines Inc. 235 San Pedro, N. W. Albuquerque, New Mexico
Originator:	L. E. Homme and R. Glaser University of Pittsburgh
History:	Conceived and developed by L. E. Homme and R. Glaser to provide the student with instruction having most of the features which programs for Skinner' s Disk Machine have, but which requires no special device other than the printed page.
Operation:	Each page of a programmed text is divided into several segments or "frames." The frames on any one page bear no relationship to each other. Frames are related to frames on the preceding and succeeding pages in the corresponding location. For example, the very first frame of a program would appear as the top segment of page 1. It would contain an open-ended statement of the Skinnerian type. The correct response to this question would appear in the top segment of page 2. The next open-ended statement would appear in the top segment of page 3 and the answer to it in the top segment of page 4, etc. When the top panel on the last page of the book is reached, the student is directed to continue with the second segment on page 1, and so on until all frames in the book have been exhausted.
Uses:	Identical with those for Skinner' s Disk Machine. However, the printed page is more flexible than Skinner's Disks, hence the programmed book can be easily adapted for presentation of pictorial or schematic material.
Physical Characteristics:	Average textbook size.
Power Requirements:	None.
References:	1. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 437-451, 1960. 2. Homme, L. E. and R. Glaser, "Relationships Between the Programmed Textbook and Teaching Machines," Automatic Teaching: The State of the Art, E. H. Galanter (Editor), John Wiley and Sons, New York, pp 103-108, 1959.


START
S-1 PAGE 1
R-3
S-6
R-8
R-1 PAGE 2
S-4
R-6
S-9
S-2 PAGE 3
R-4
S-7
R-9
R-2 PAGE 4
S-5
R-7
S-10
S-3 PAGE 5
R-5
S-8
R-10
THE END



WYCOFF FILM TUTOR

Date: 1959

Cost: $445.00

Source:

Teaching Machines Inc.
235 San Pedro N. E.
Albuquerque, New Mexico

Originator:

B. Wycoff
Emory University
Atlanta, Georgia

History: Conceived by B. Wycoff and developed by Teaching Machines Inc. as a device which could compare an answer composed by a student to the correct answer on microfilm and one which would advance to the next frame only when the answer that was given was entirely correct.

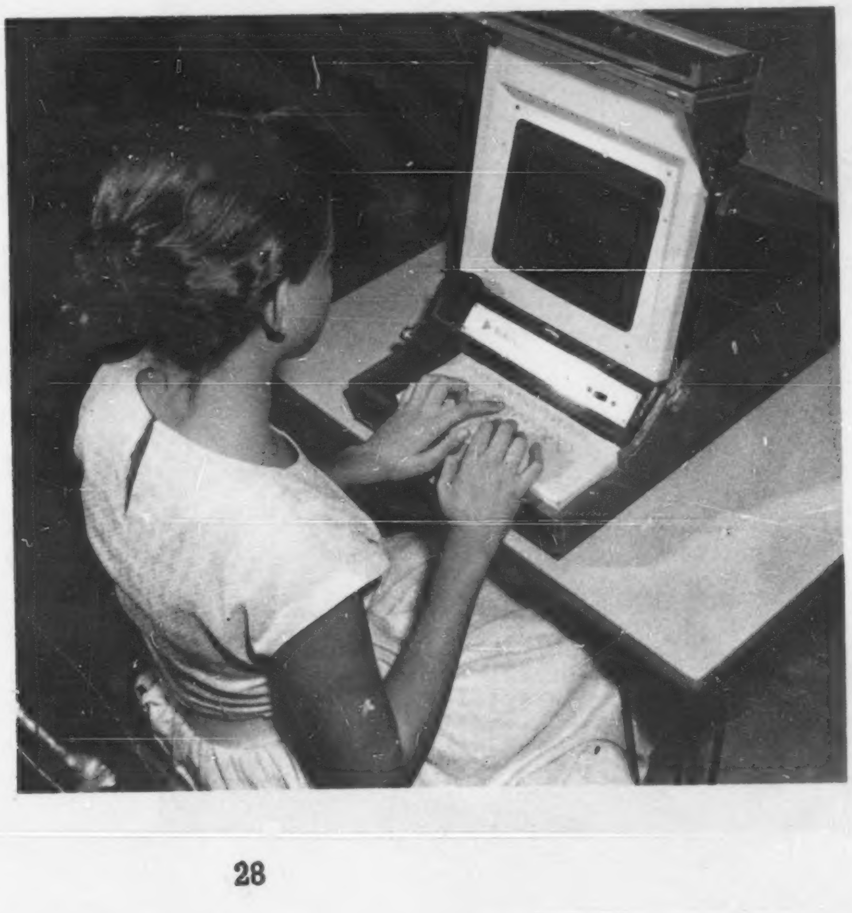
Operation: The material to be learned is projected on a screen from 35mm microfilm. The trainee attempts to construct his answer on a typewriter keyboard. Only the situationally and sequentially correct key can be depressed and will advance the next frame of film. All other keys are locked. There is no provision for keeping a record of the correct and incorrect answers. The device holds 300 frames of 35mm film, and it does not require reels.

Uses: The primary use is for teaching spelling.

Physical Characteristics: Weight: 30 pounds; Width: 15 inches; Depth: 24 inches; Height: 15 inches (open).

Power Requirements: 115 volts, less than 5 amps.

References: None.



VISITUTOR - FILM MODEL **Date:** 1959

Source: Hamilton Research Associates Inc.
4 Genesee Street
New Hartford, New York

Cost: Unavailable

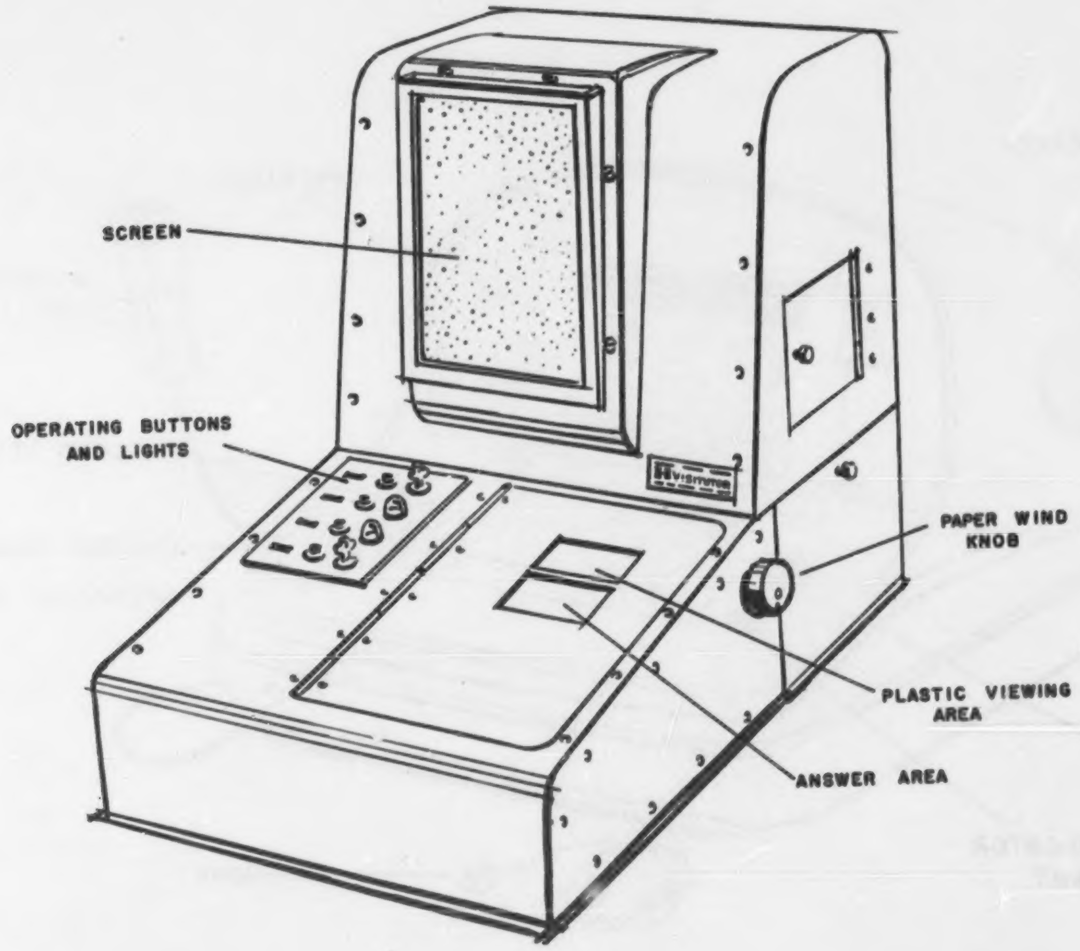
Originator: Blythe, Jacobson and Godcharles, Hamilton College, Clinton, N. Y., and Garbielson, Hamilton Research Associates Inc.

Description: The Visitutor differs from the Wycoff Film Tutor in that the Visitutor exposes the correct answer immediately following the trainee' s response. After the trainee has seen the correct answer, he must construct the correct answer in the correction space before the next item is exposed. The Visitutor requires the trainee to write out his answer rather than type it out. There is no automatic scoring feature, however the number and kinds of error are easily ascertained by quick inspection of the answer sheet.

Physical Characteristics: Weight: 30 pounds; Width: 15 inches; Depth: 23 inches; Height: 18 inches.

Power Requirements: 110 volts ac, 4 amps.

Reference: None.



AUDITUTOR

Date: 1960

Source: Hamilton Research Associates, Inc.
4 Genesee Street
New Hartford, New York

Cost: Undetermined

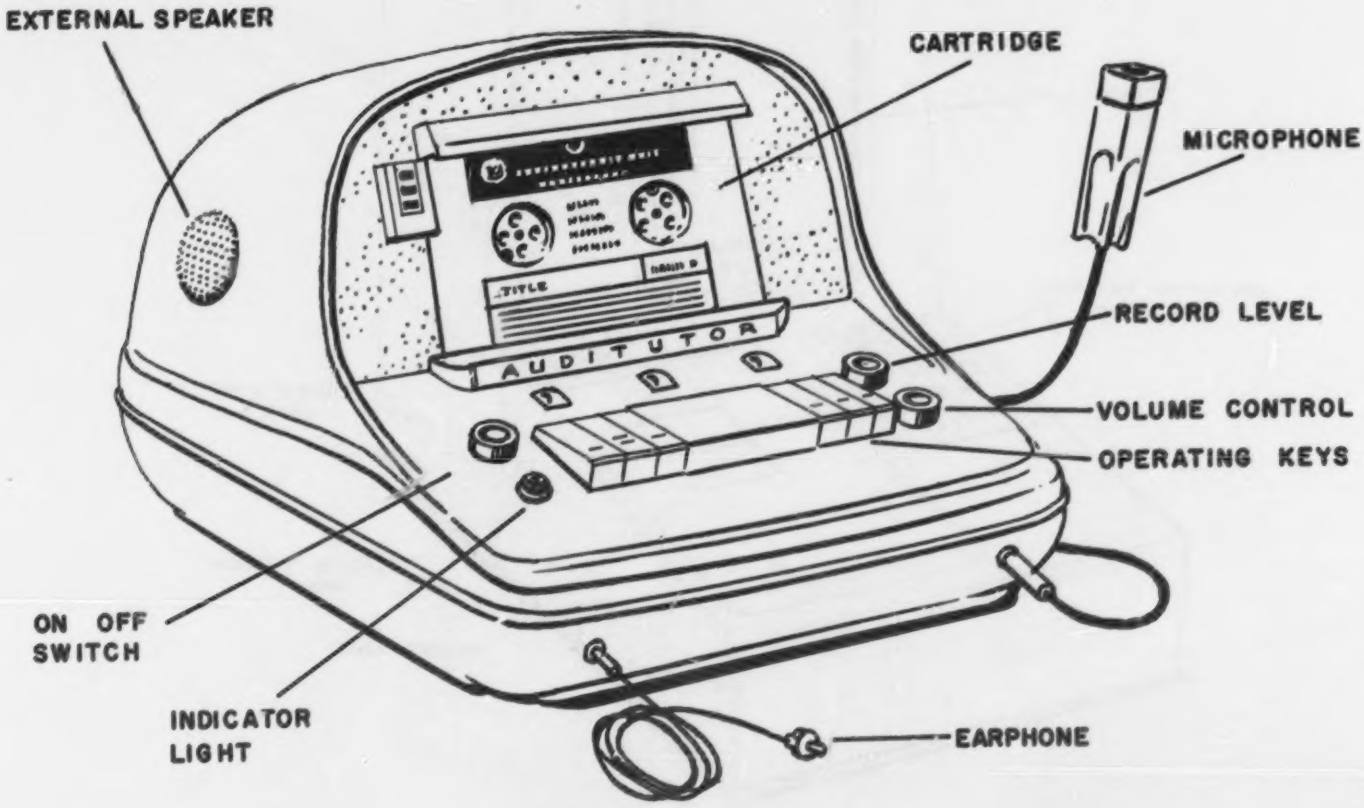
Originator: R. Hedderick, Hamilton Research Associates, Inc., and Blythe, Godcharles and Jacobson, Hamilton College, Clinton, N. Y.

Description: The material to be learned is presented on tape. The trainee advances the tape to any area he desires, by reference to a footage index on the tape cartridge. The machine plays this unit of instructional material from Track No. 1 of the tape. The student answers by speaking into a microphone, thereby recording his answer on Track No. 2 of the tape. The Auditutor then automatically stops, giving the student the option of: (1) advancing to the next segment of instructional material, (2) reviewing preceding instructional material and answers, or (3) re-recording previous answer.

Physical Characteristics: Weight: 35 pounds; Width: 16 inches; Depth: 20 inches, Height: 14 inches.

Power Requirements: 115 volts ac, 2 amps.

Reference: None.


EXTERNAL SPEAKER
CARTRIDGE
MICROPHONE
TITLE
AUDITUTOR
RECORD LEVEL
VOLUME CONTROL
OPERATING KEYS
ON OFF SWITCH
INDICATOR LIGHT
EARPHONE

ARITHMETIC MACHINE

Date: 1954

Source: Not commercially available.

Cost: Unknown

Originator: B. F. Skinner
Harvard University

History: Developed by B. F. Skinner as a teaching tool which can provide immediate reinforcement.

Operation: An arithmetical problem is presented in a window in the form of a statement or of an arithmetical expression with a few letters or figures missing. The pupil moves the sliders on the front panel which cause letters or figures to appear. When an answer has been composed, the pupil turns a crank. If the answer is correct, a new frame of material moves into the window and the sliders return to their original position. If the answer is wrong, the sliders return, but the frame remains and the trainee must try again. This device, like the Wycoff Tutor (page 28) will report a wrong answer without giving the right answer. It also has an automatic scorer to tally wrong answers.

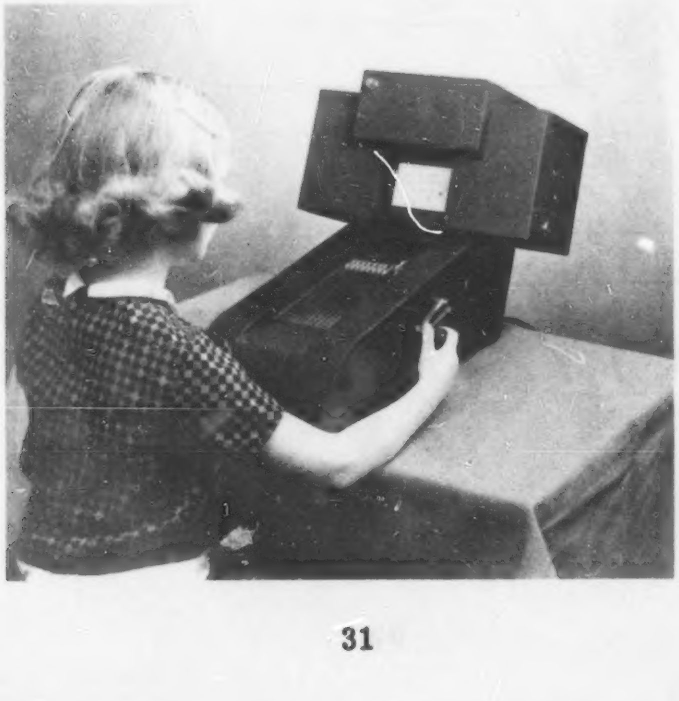
Uses: It can be used to teach mathematics and with some minor modifications it can teach spelling, reading, and verbal relationships that are necessary in science and logic. This device is particularly suited to teaching the lower grades.

Physical Characteristics: Size of a small record player.

Power Requirements: 110 volts ac, low amps.

References:

1. Skinner, B. F., "The Science of Learning and the Art of Teaching," Harvard Educational Review, XXIV, No. 2, pp 86-97, Spring 1954, Reprinted in Reference 2.
2. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 99-113, 1960.



ARITHMACHINE NO. 1

Date:

Source: Not commercially available.

Cost: Unknown

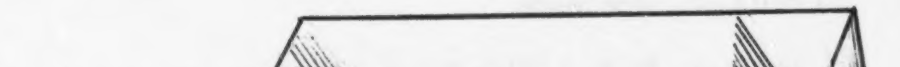
Originator: D. Zeaman
University of Connecticut
Storrs, Connecticut

Description: A problem appears in the large window on the face of the machine. The problem might be of any degree of difficulty from 2 times 2 up to a problem in long division or square-root derivation. The student composes his answer by moving the four plungers at the front of the machine. These operate the dials to show his answer in the aperture below the problem. When he is satisfied with his answer, the student turns the crank at the right. If the answer is correct, the machine advances to the next problem by moving a tape on which the problems are printed. If wrong, it scores an error and leaves the problem unchanged so that he must try again until he gets the correct answer before he can proceed.

Physical Characteristics: Unknown

Power Requirements: Unknown

Reference: Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 8-10, 1960.



Date: 1958

ARITHMACHINE NO. 2

Cost: Unknown

Source: Not commercially available

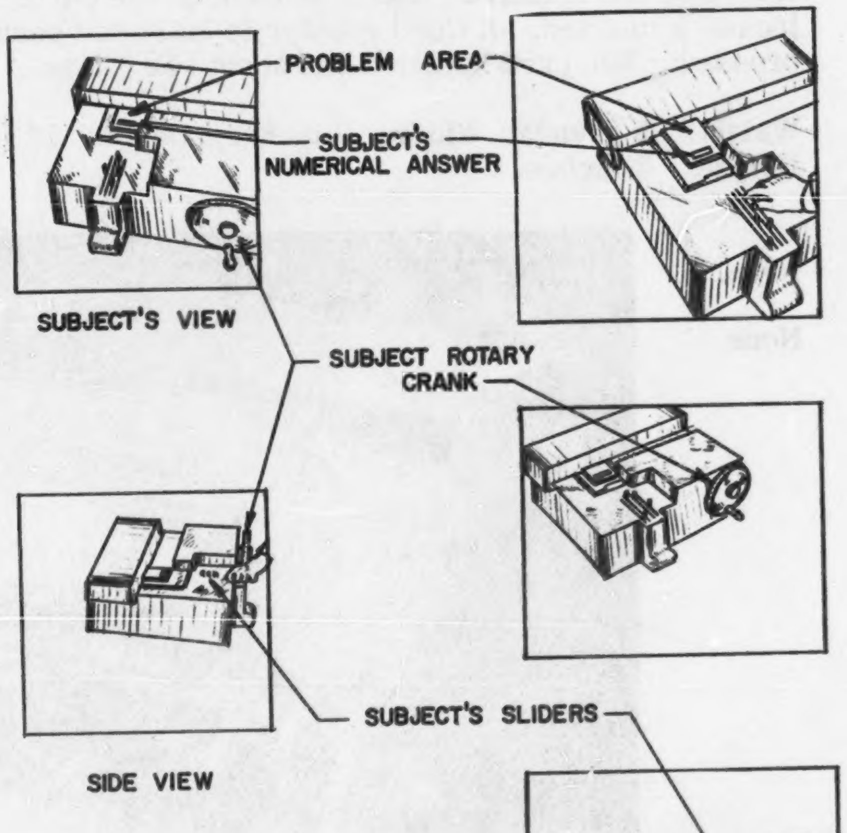
Originator: Rationale came from B. F. Skinner. It was designed by S. Orlando, and the planning and experimentation was done by D. Zeaman, Department of Psychology, University of Connecticut, Storrs, Connecticut.

Description: This machine is very similar to Skinner's Arithmetic Machine. The machine visually presents an unlimited series of arithmetical problems, allows the operator to make any one of 10,000 different numerical responses (numbers 0- 9,999), immediately informs the subject whether he is right or wrong, permits correction of wrong responses, changes the problem after right answers, and records right and wrong responses.

Physical Characteristics: Not available.

Power Requirements: None.

Reference: None.


PROBLEM AREA
SUBJECT'S NUMERICAL ANSWER
SUBJECT'S VIEW
SUBJECT ROTARY CRANK
SUBJECT'S SLIDERS
SIDE VIEW

SAKODA'S SORTCARD AUTOMATIC TUTOR

Date: 1959

Cost: $285.00

Source:
Scientific Prototype Manufacturing Corp.
623 West 129th Street
New York 27, New York

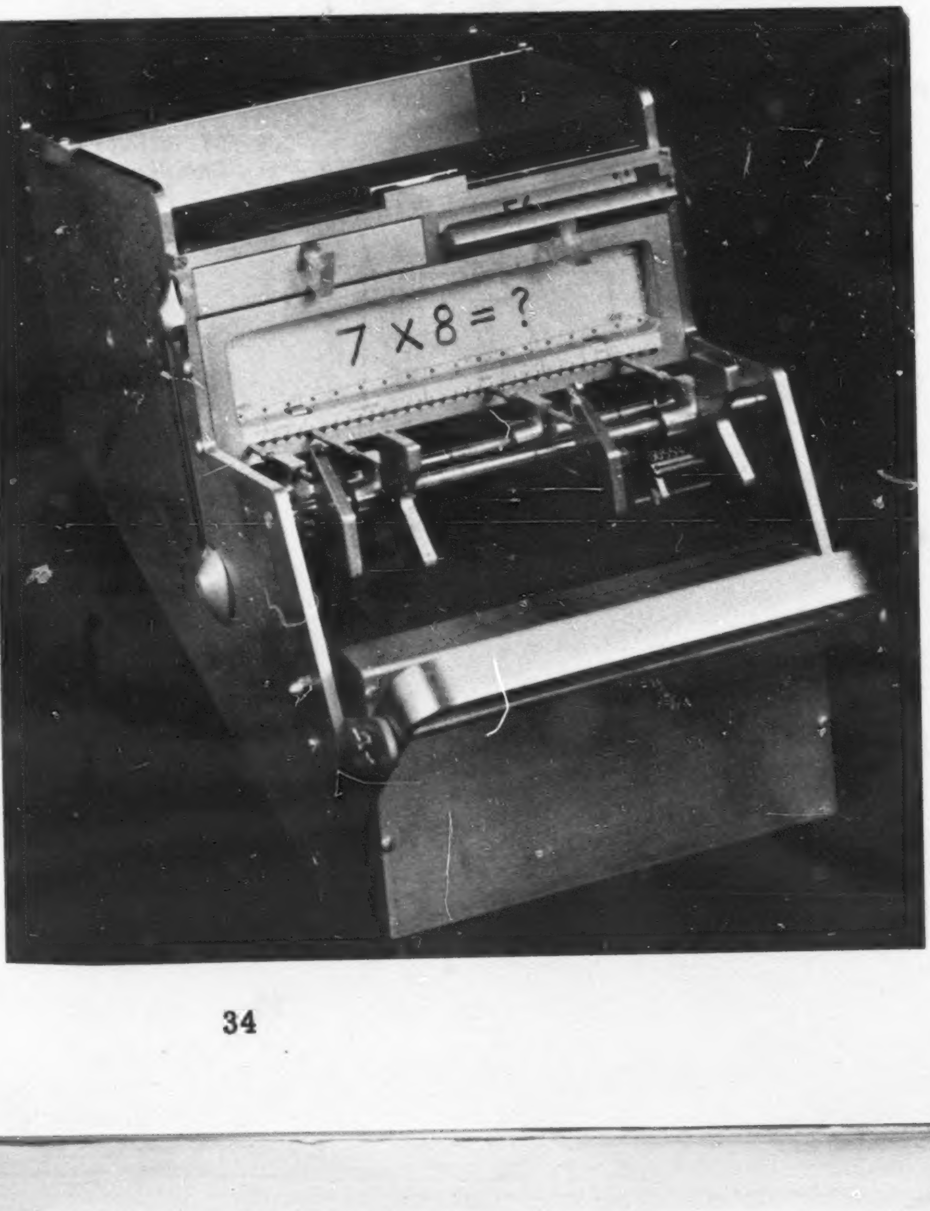
Originator:
M. Sakoda
University of Connecticut
Storrs, Connecticut

Description: The instructional material is printed on standard check-sized keysort cards available from the Royal-McBee Corporation. Both the problem and alternative answers are located on the face of the card. Numbers from 0000 to 4999 are printed on each card from which the student selects his answer. The subject moves four selector pins into four positions to indicate his answer and pushes a bar to see whether his answer is correct or not. If his answer is correct the card is pushed up through a slot and can be removed by hand. Otherwise, he must try another answer and continue to do so until he gets the correct one. Above the window showing the problem are two doors behind which are the hints and the answer. Every time a door is opened, a counter is activated and a marker leaves a mark on the card. Either door can be locked if desired. A third counter is activated each time the bar is pressed. The card holder holds about 150 cards.

Physical Characteristics: Weight: 5 pounds; Width: 9 inches; Depth: 12 inches; Height: 8 inches.

Power Requirements: None.

Reference: None.



DEVEREUX TEACHING AID - MODEL 90

Date: 1960

Cost: $49.50

Source:
Smith-Harrison Inc.
Box 717
Devon, Pennsylvania

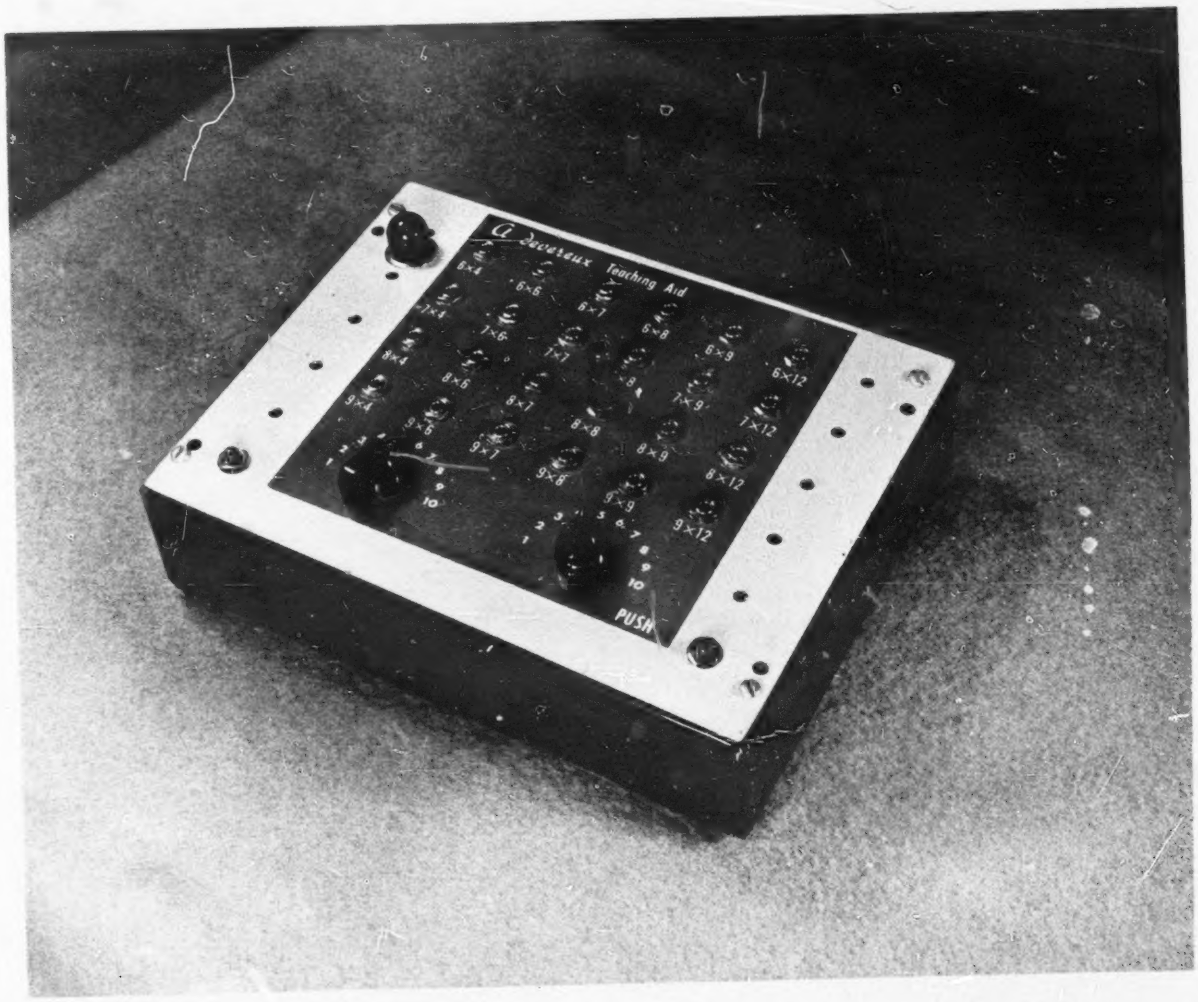
Originator:
E. A. Smith
Devereux School
Devon, Pennsylvania

Description: The trainee places the plug in a hole above the problem he wants to solve. To indicate his answer, he sets the dials to the number that represents the product of his problem. He then pushes a button to verify his answer. A green light or buzzer indicates a correct answer. This device can only be used to teach multiplication tables 4, 6, 7, 8, 9, and 12. Unlike Skinner's Arithmetic Machine, it does not have the scoring feature.

Physical Characteristics: Weight: Approximately 3 pounds; Width: 9 inches; Depth: 7 inches; Height: 4 inches

Power Requirements: 3 volt batteries

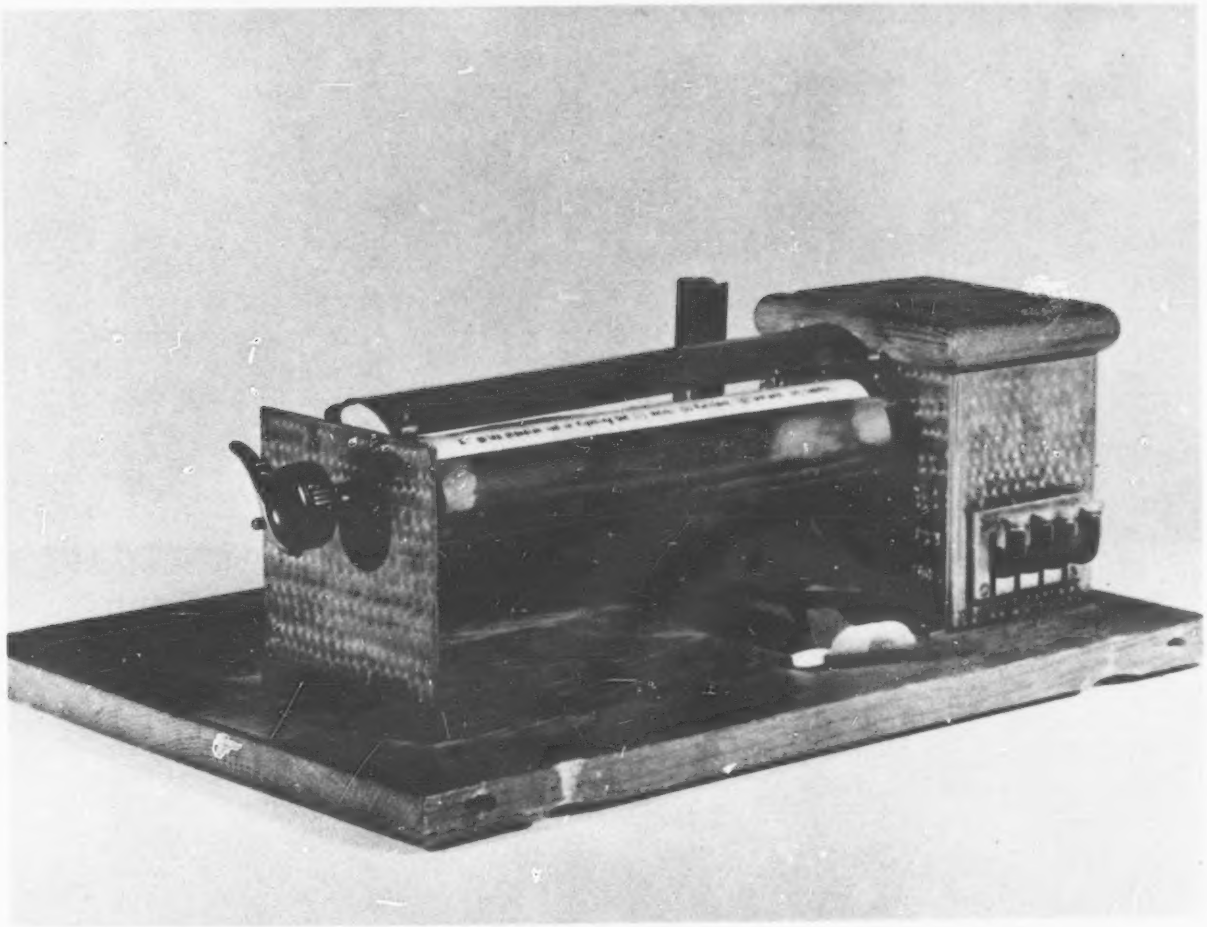
Reference: None.

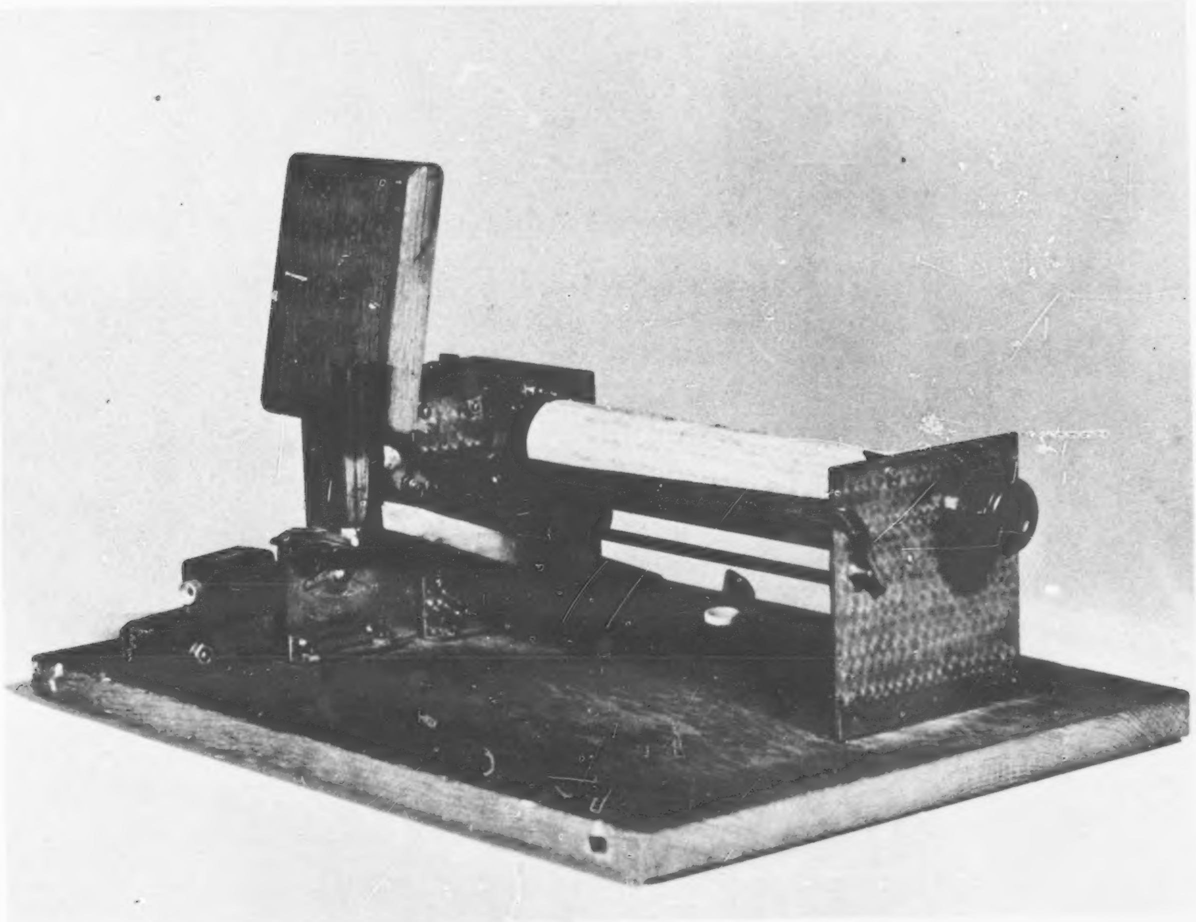


A Devereux Teaching Aid
6×4
6×6
6×7
6×8
6×9
6×12
7×4
7×6
7×7
7×8
7×9
7×12
8×4
8×6
8×7
8×8
8×9
8×12
9×4
9×6
9×7
9×8
9×9
9×12
PUSH

PRECEDING PAGE BLANK- NOT FILMED

PRESSEY MACHINES





SELF-SCORING MULTIPLE-CHOICE DEVICE

Date: 1924

Cost: Unknown

Source: Not commercially available

Originator: S. Pressey
Ohio State University
Columbus, Ohio

History: Originally conceived and developed by Pressey as a self-testing device intended to save the teacher' s time by minimizing the need for correcting tests. This machine was later modified so that it could serve as a teaching device. It was the first device of its type whose design was influenced by scientific principles of human learning.

Operation: The material to be learned appears in the form of a multiple-choice question in the window. To one side of the window are four keys. The trainee indicates his answer by pressing the key corresponding to his choice. If he is correct, the material advances to a new question. If he is incorrect, he must keep trying until he finds the correct answer. There is a tally register which keeps track of the number of correct answers and also of the number of attempts the student makes at each question. A reward feature can be incorporated into this device. A piece of candy or other type of reward can be delivered through a slot when the correct answer has been determined.

Uses: This device can be used to teach any type of multiple-choice material. It can also be used, of course, as a testing and scoring device for multiple-choice material. Originally intended for use with children.

Physical Characteristics: Unknown.

Power Requirements: None.

References:

1. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 35-41, 1960, Reprinted in Reference 2.
2. Pressey, S. L., "A Simple Apparatus Which Gives Tests and Scores and Teaches," School and Society, 23, No. 586, pp 373-376, March 20, 1926.

MULTIPLE-CHOICE RESPONSE DEVICE **Date:** 1927

Source: Not commercially available **Cost:** Unknown

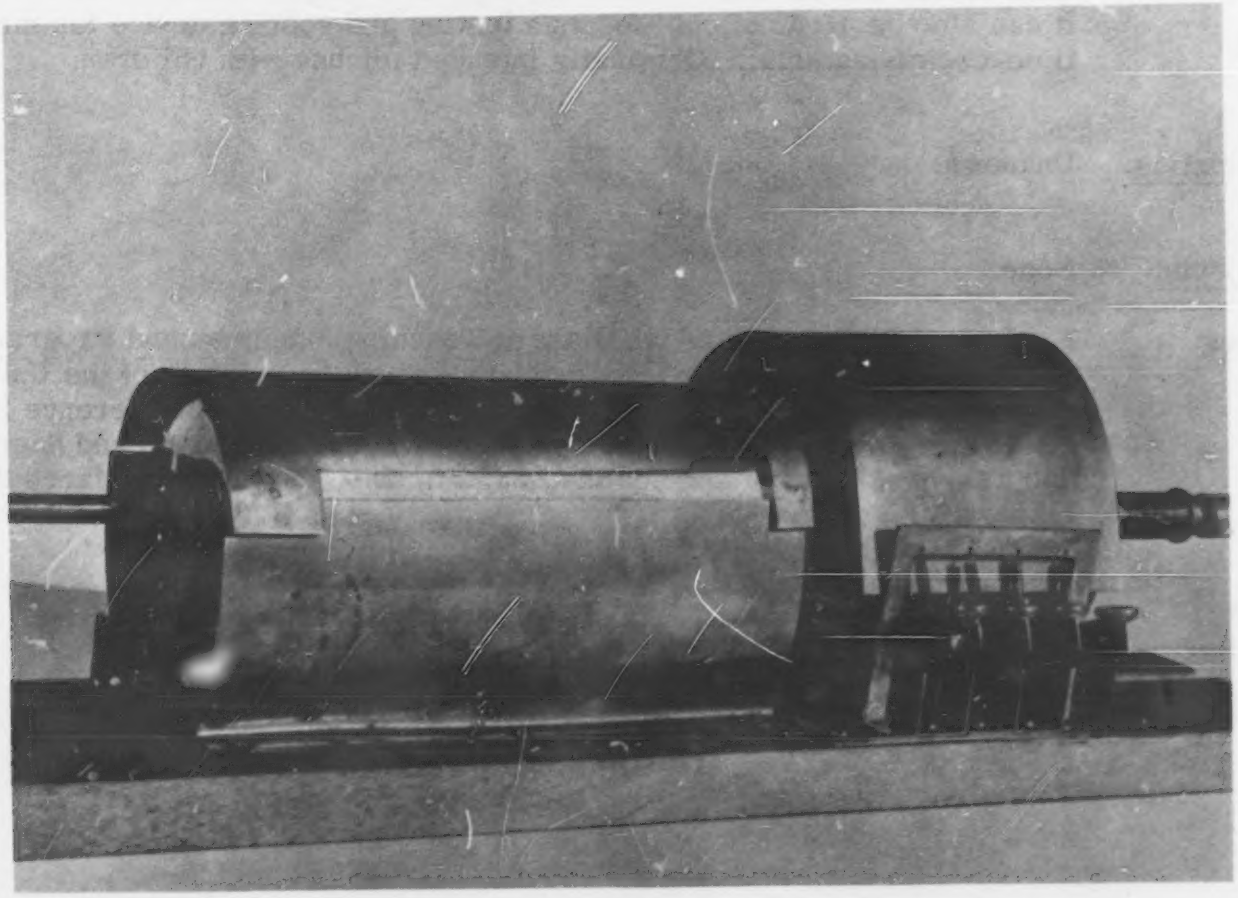
Originator: S. L. Pressey
Ohio State University
Columbus, Ohio

Description: Functional characteristics the same as Pressey's "Self-Scoring" device, although this device has a drop-out feature which eliminates the items that are answered correctly twice in a row.

Physical Characteristics: Not available

Power Requirements: Unknown

References:
1. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 42-46, 1960, Reprint of Reference 2.
2. Pressey, S. L., "A Machine for Automatic Teaching of Drill Material," School and Society, 25, pp 549-552, May 7, 1927.



SCORING AND TABULATING MACHINE

Date: 1932

Cost: Unknown

Source: Not commercially available

Originator: S. L. Pressey
Ohio State University
Columbus, Ohio

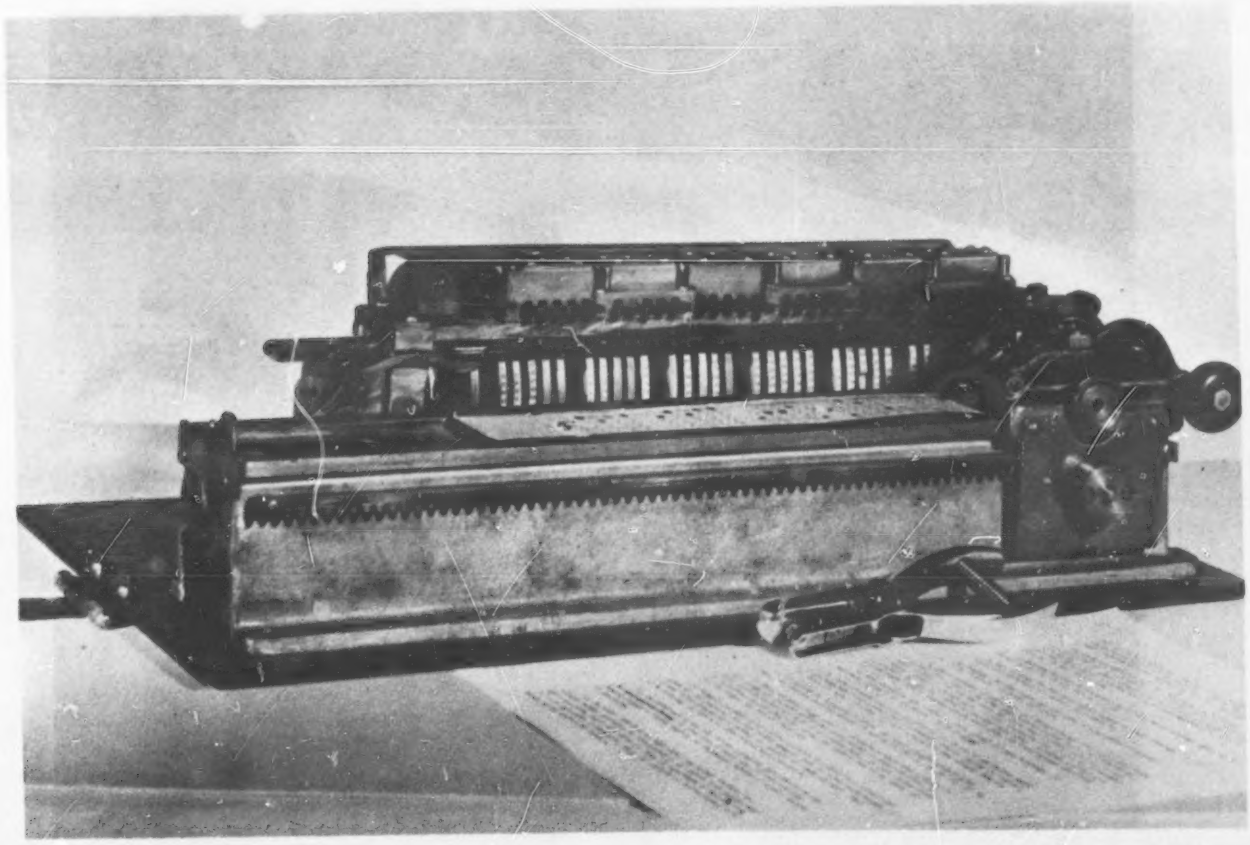
Description: The student indicates his answers to questions on a separate sheet of paper by punching a thin strip of cardboard. The student can write his name on the top of the strip. Below are 30 rows of five 3/16-inch circles. The student indicates his answer to a question by punching through the appropriate circle with a hand punch. The answer spaces contain pens which spring up if the correct answer is punched. If the answer is not correct, the pens are held down. It is primarily an automatic scoring device.

Physical Characteristics: Unknown

Power Requirements: None

References:

1. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 47-51, 1960. Reprint of Reference 2.
2. Pressey, S. L., "A Third and Fourth Contribution Toward the Coming 'Industrial Revolution' in Education," School and Society, 36, pp 668-672, November 19, 1932.



DRUM TUTOR

Date: 1946

Source: Not commercially available

Cost: Unknown

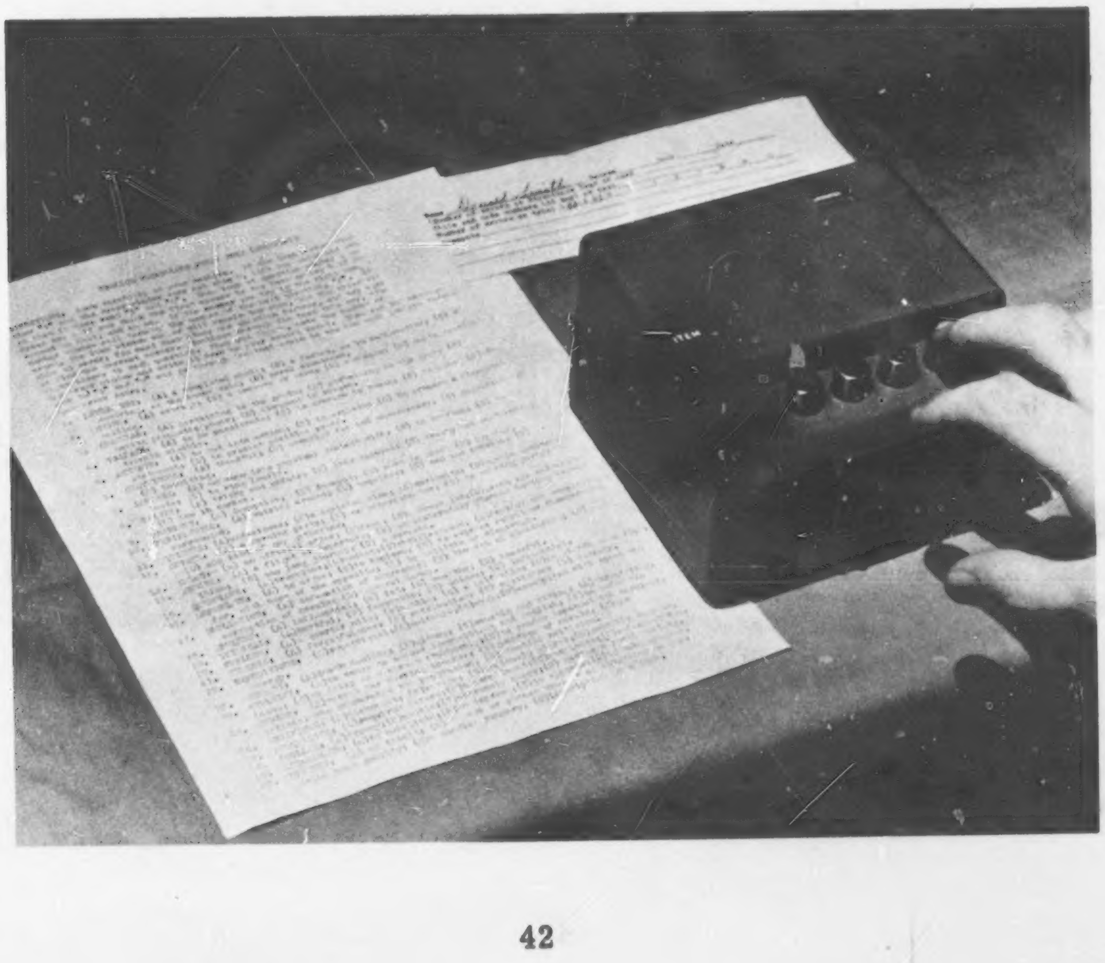
Originator: Conceived by S. L. Pressey, Ohio State University, Columbus, Ohio, and developed by U. S. Navy Special Devices Center, Port Washington, New York.

Description: The instructional material is presented on a mimeographed sheet, separate from the answer indicator. The sheet contains forty 4-choice multiple-choice items. The item counter indicates to the trainee on which item he is to work. The trainee responds by pressing that answer button on the tutor which corresponds to his answer choice. He must choose the correct answer before he can progress to the next item. The error counter indicates cumulative errors the trainee has made during any one program. It is possible to provide a considerable number of programs with different arrangements of correct answers. This device is very similar to Pressey' s Multiple-Choice Device (see page 40).

Physical Characteristics: Weight: 1 pound; Width: 4 inches; Depth: 4 inches; Height: 3 inches.

Power Requirements: None

Reference: Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 88, 89-93, 1960.



ATRONIC TUTOR - MODEL 580 **Date:** 1959

Source: General Atronics Corporation
1 Bala Avenue
Bala-Cynwyd, Pennsylvania

Cost: $150.00

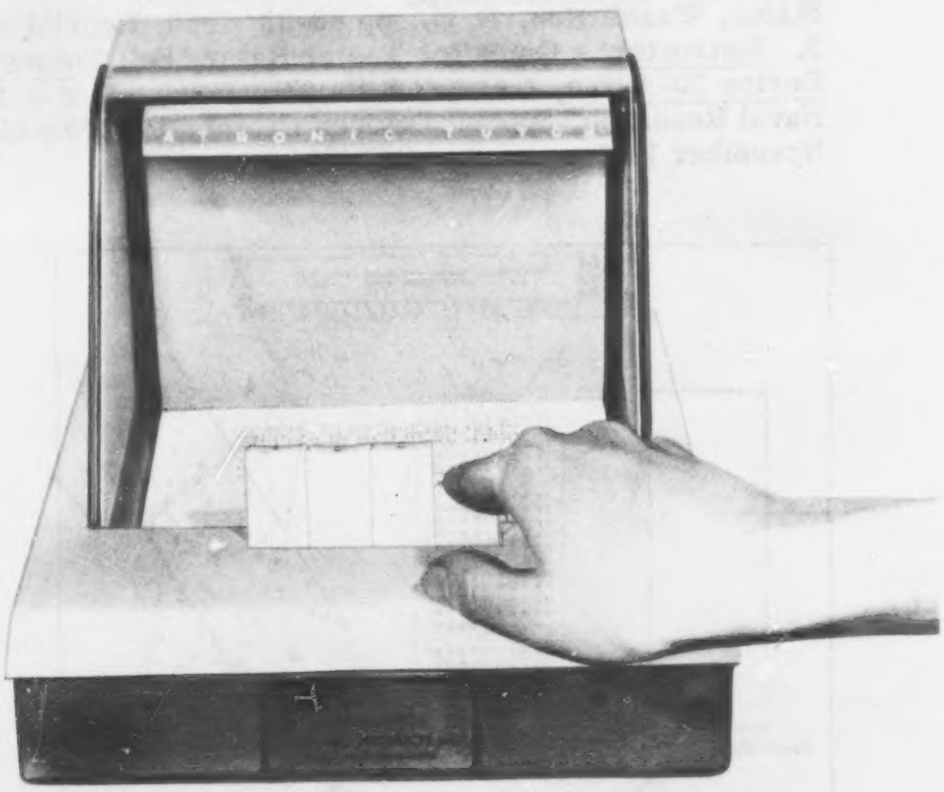
Originator: General Atronics Corporation

Description: This device has the same features as Pressey' s Self-Scoring Device (see page 39). The instructional material is prepared on specially cut cards and bound into a pad, which is inserted into the device. The student reads the first card (or page) of this material and makes his choice of answer by pressing one of four keys. If his choice is correct, the next page is released, falls to the bottom, and exposes its contents. If the answer is incorrect, the page is not released. Every key activation is recorded by a mechanical counter which can be reset when a new program is placed in the tutor.

Physical Characteristics: Weight: 7-15 pounds; Width: 8-1/2 inches; Depth: 11 inches; Height: 10 inches.

Power Requirements: None

Reference: None



TESTER-RATER SELF-TUTORING PUNCHBOARD DEVICE **Date:** 1959

Source: U. S. Printing and Novelty Company **Cost:** Unknown
195 Chrystie Street
New York 2, New York

Originator: S. L. Pressey
Ohio State University
Columbus, Ohio

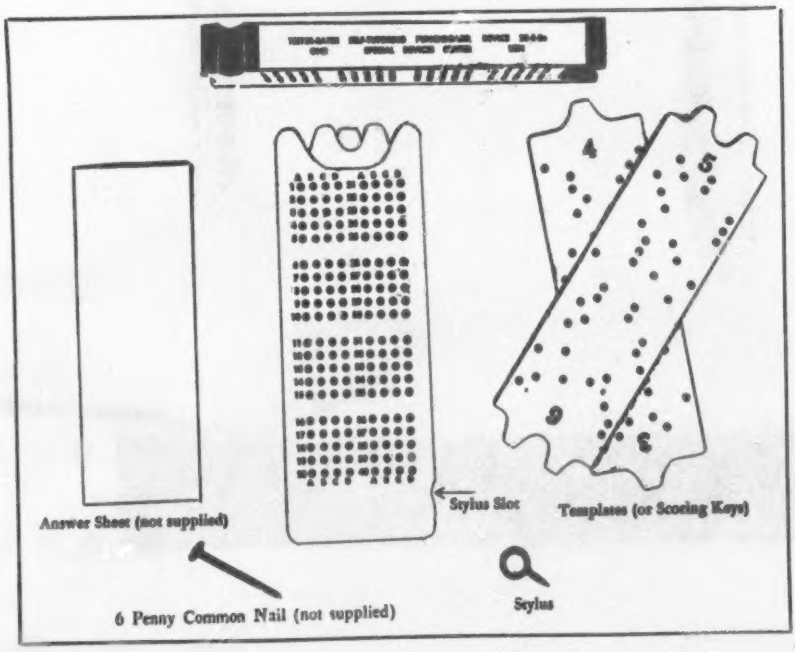
Description: Instructive multiple-choice questions are mimeographed on ordinary paper. Instead of indicating his response by pressing buttons, the trainee indicates his answer by punching one of the four choices to the question on the punchboard. If the answer is correct, the pin penetrates all the way. If the answer is incorrect, the pin penetrates only half way. A sheet of paper inside the punchboard provides a record of errors and correct answers.

Physical Characteristics: Weight: 8 ounces; Width: 3 inches; Depth: 8 inches; Height: 1 inch.

Power Requirements: None

References:

1. Pressey, S. L., "Development and Appraisal of Devices Providing Immediate Scoring of Objective Tests and Concomitant Self-Instruction," Journal of Psychology, 29, pp 417-447, April 1950.
2. Lumsdaine, A.A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 69-88, 1960, Reprint of Reference 1.
3. Instructor' s Guide for Tester Rater, Self Tutoring Punchboard, Device 20-E-2-e, NAVEXOS P-1271, Department of the Navy, Office of Naval Research, Special Devices Center, Port Washington, New York, November 1955.


4
5
9
6
Answer Sheet (not supplied)
Stylus Slot
Templates (or Scoring Keys)
6 Penny Common Nail (not supplied)
Stylus

IBM PUNCH-CARD SELF-TEACHING DEVICE

Date: 1958

Source: Stationery Store

Cost: Unknown

Originator: S. L. Pressey and developed by C. Willey, Norwich University, Northfield, Vermont

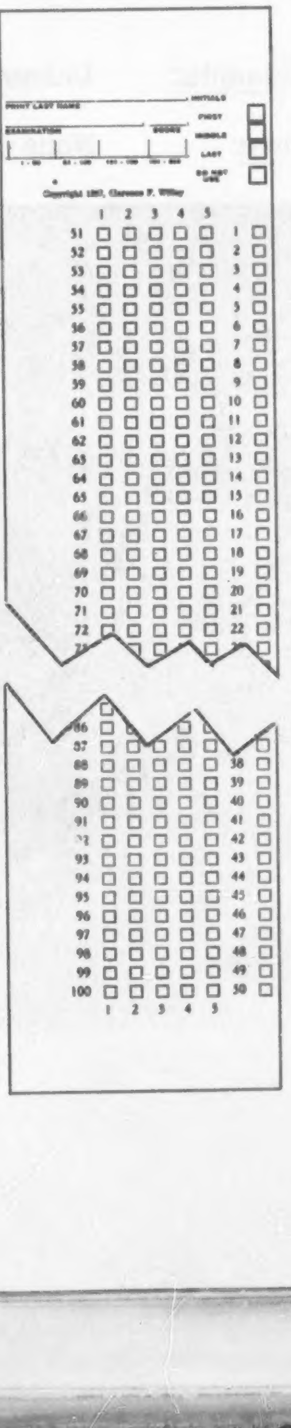
Description: Multiple-choice response material is mimeographed on ordinary paper. The trainee reads the question and indicates his preference by marking the number 1 space on the Pegboard Marginal Response (PMR) answer sheet representing his choice (see figure). He then checks this choice by punching the corresponding space on the IBM punch-card device (very similar to Pressey' s punchboard, page 44). (The only difference between Pressey' s punchboard and the IBM punch-card device is that the latter uses an IBM punch card as the top response sheet and Pressey' s punchboard uses any multiple-choice answer sheet that will fit the punchboard.) If the stylus goes through the "sandwich" without being blocked, the trainee knows he is correct. If it does not, then the trainee knows he is incorrect and must try again. This technique is very similar to Pressey' s punchboard technique (page). The only difference is that the former's use of the PMR answer sheet is to provide an immediate tabulation and analysis of the trainee' s responses. A similar technique has been developed by J. Sakoda, University of Connecticut, Storrs, Connecticut.

Physical Characteristics: 1 unpunched IBM card, 2 IBM cards punched for incorrect or correct answers, 1 sheet easily breakable paper, 2 spacer panels (IBM cards that are completely punched), and a stylus.

Power Requirements: None

References:

1. Willey, Clarence F., "Classroom Scoring of Tests," Psychological Reports, 4, pp 611-617, 1958.
2. Willey, Clarence F., "The PMR Answer Sheet," Educational and Psychological Measurement, XVIII, No. 3, pp 589-596, 1958.
3. Sakoda, J. M. and M. Greenwood, "Construction and Use of an Auto-Instructional Punchboard with IBM Cards," Psychological Reports, 8, pp 207-216, April 1961.



DEVEREUX TEACHING AID - MODEL 15

Date: 1960

Cost: $15.00

Source: Smith-Harrison, Inc.
Box 717
Devon, Pennsylvania

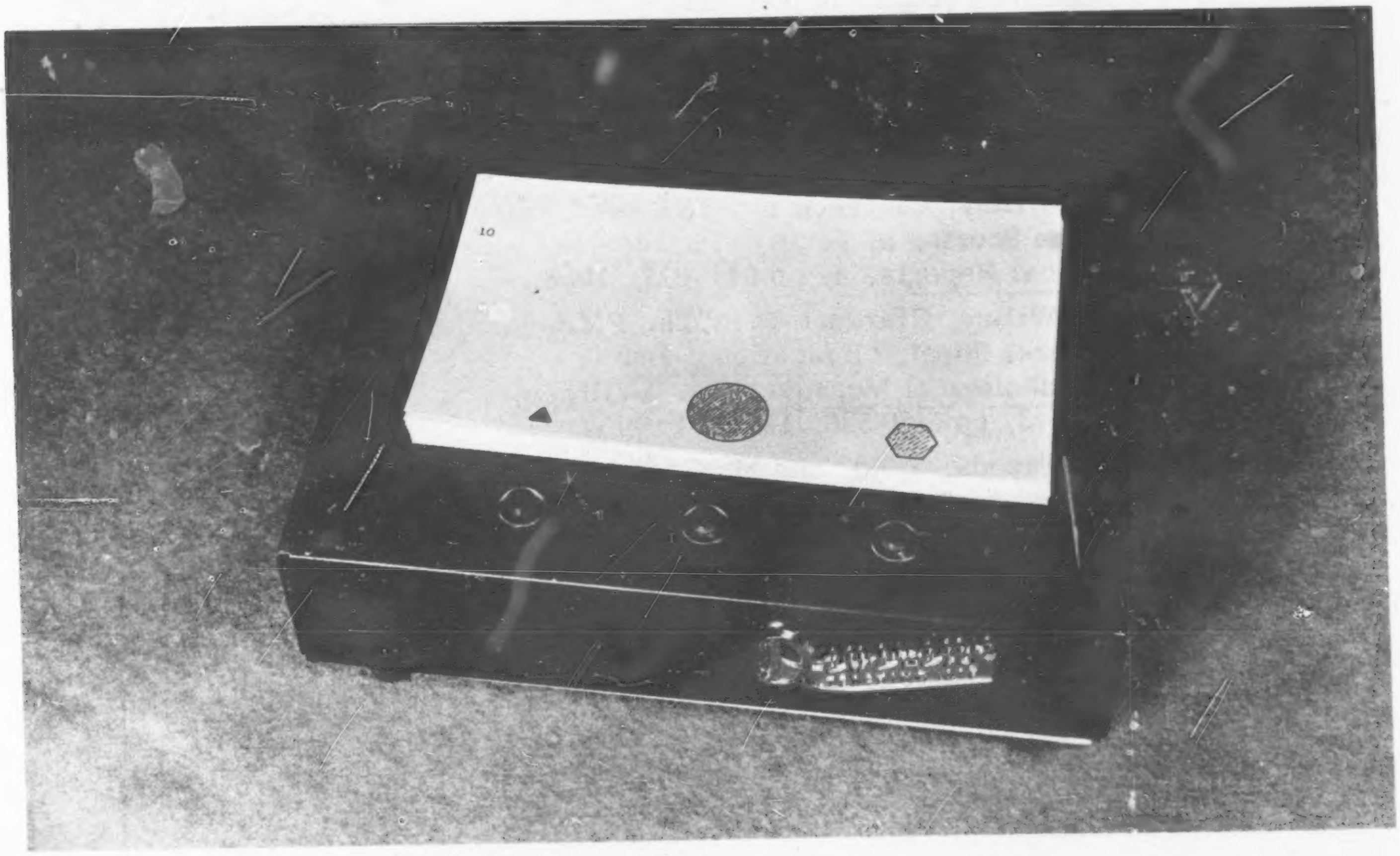
Originator: E. A. Smith
Devereux Schools
Devon, Pennsylvania

Description: Used primarily for individual work with very young children or retarded persons. The instructional materials are on cards and the teacher may ask any desired question about the material. Possible questions asked might be: "Which of these is the larger?" (See example.) The trainee answers by pressing one of the buttons corresponding to his choice. On the rear of the device is a second set of three buttons. If the teacher desires the second picture as the correct answer, she depresses the second button. As a result there is no prearranged set of responses; the teacher makes up the problems as she goes.

Physical Characteristics: Weight: Unknown; Width: 9 inches; Depth: 7 inches; Height: 4 inches.

Power Requirements: Unknown

Reference: None



Date: 1960

DEVEREUX TEACHING AID - MODEL 50

Cost: $90.00

Source: All American Engineering
Wilmington, Delaware

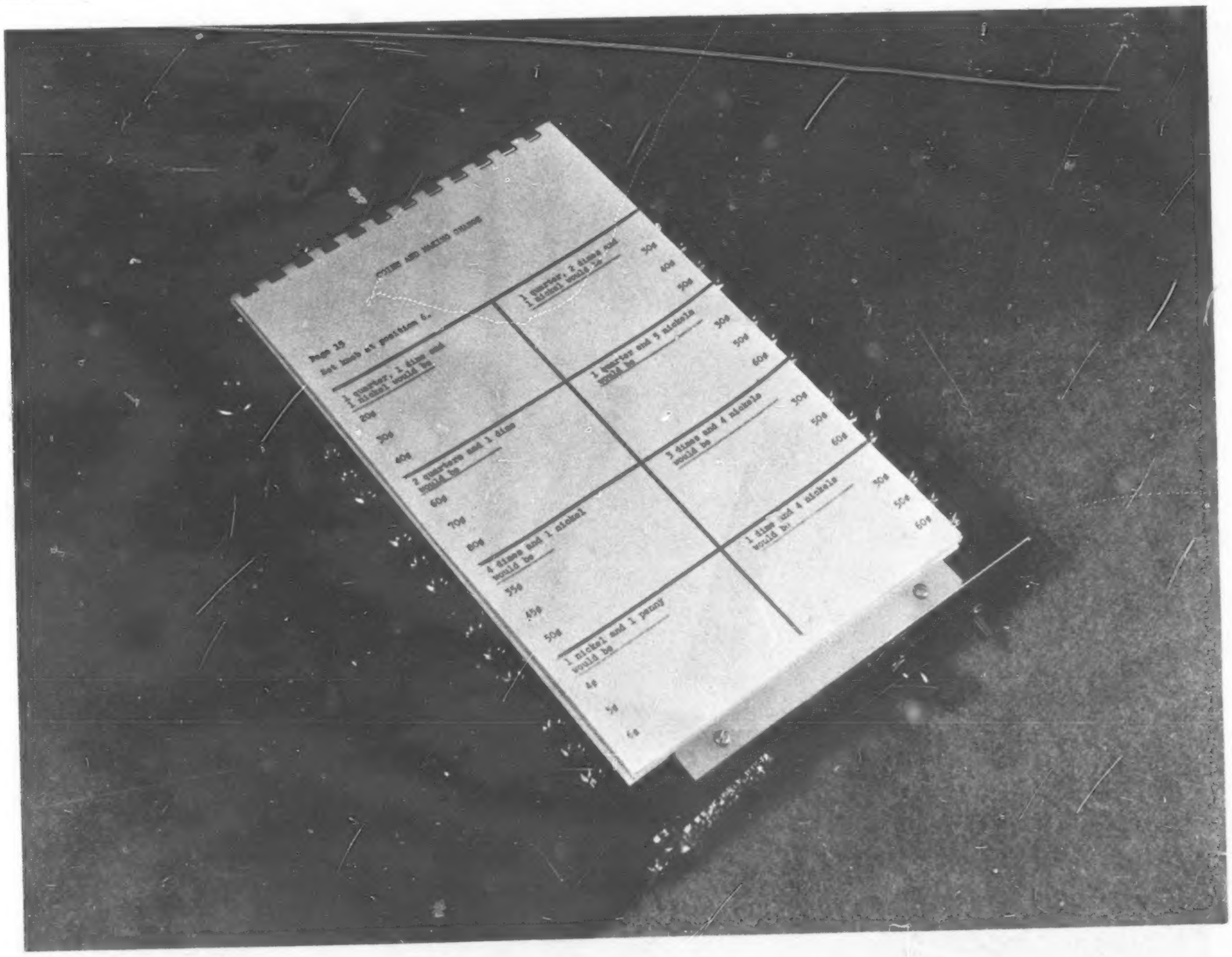
Originator: E. A. Smith
Devereux Schools
Devon, Pennsylvania

Description: The instructional material is in a booklet located on top of the machine. Before working each problem, the student sets the rotary switch located at the top of the page of the booklet. Each problem has a choice of three answers, the student indicating his choice by pressing a button next to the desired answer. If the answer is correct, a green light comes on or a buzzer sounds; if nothing happens the student knows he is wrong. This device has no automatic scoring feature. Primarily for use with children or retarded persons.

Physical Characteristics: Weight: 3 pounds; Width: 10 inches; Depth: 16 inches;
Height: 4 inches, measured at back of box.

Power Requirements: 3 volts (2 flashlight batteries)

Reference: None


COINS AND MAKING CHANGE
Page 15
Set knob at position 6.
1 quarter, 1 dime and 1 nickel would be
20¢
30¢
40¢
2 quarters and 1 dime would be
60¢
70¢
80¢
4 dimes and 1 nickel would be
35¢
45¢
50¢
1 nickel and 1 penny would be
4¢
5¢
6¢
1 quarter, 2 dimes and 1 nickel would be
30¢
40¢
50¢
1 quarter and 5 nickels would be
30¢
50¢
60¢
3 dimes and 4 nickels would be
30¢
50¢
60¢
1 dime and 4 nickels would be
30¢
50¢
60¢

DEVEREUX TEACHING AID - MODEL 80

Date: 1960

Cost: $110.00

Source:

Smith-Harrison, Inc.
Box 717
Devon, Pennsylvania

Originator:

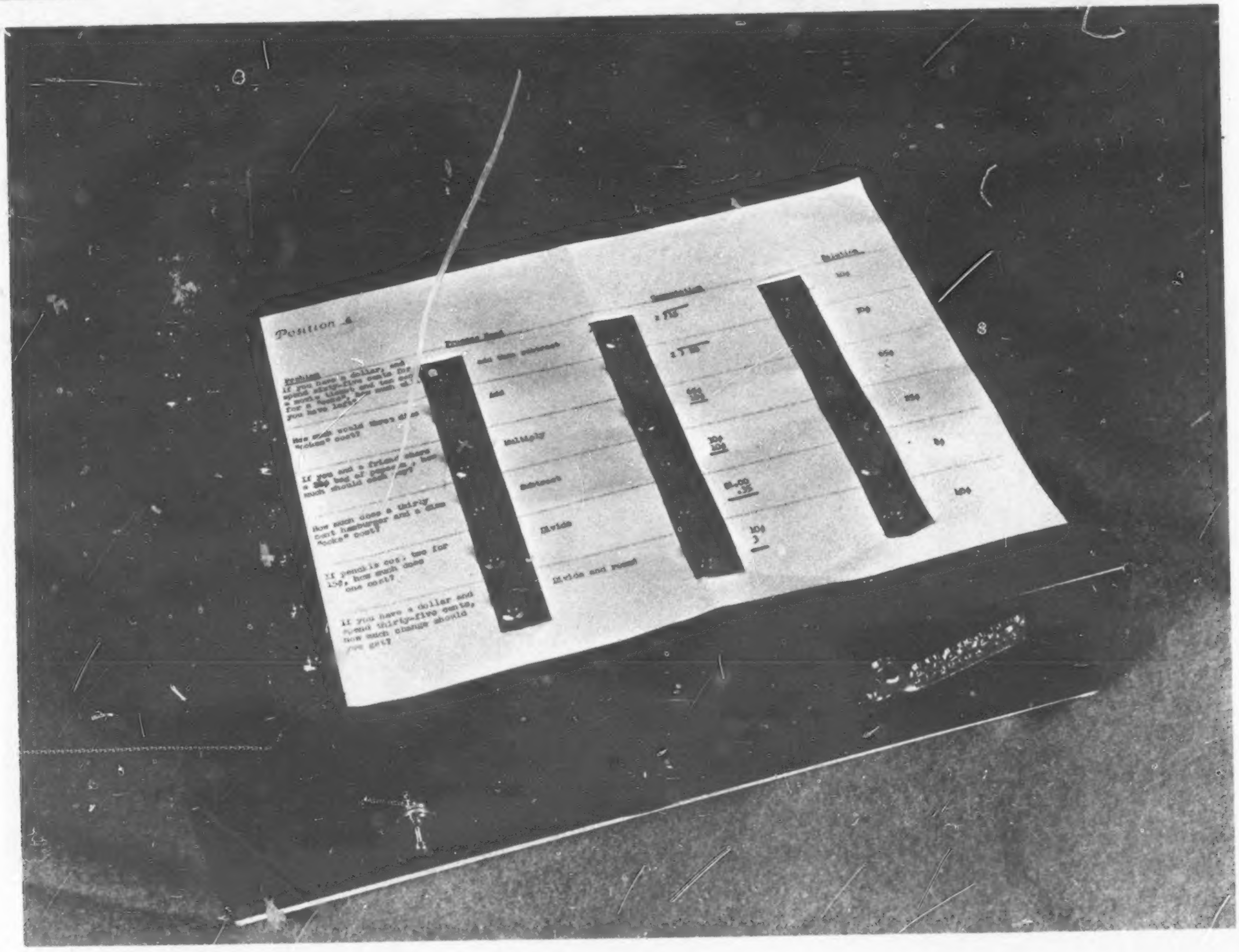
E. A. Smith
Devereux Schools
Devon, Pennsylvania

Description: Very similar to Model 50 but a little more complex. Instead of three similar type of responses, the responses are of a problem-solving type -- requiring specification of the steps leading to the final answer. Hence a demonstration of knowledge of the solution processes is involved. The trainee has only one choice for each step in the process involved, but some of the alternatives at each step are wrong. He indicates the correct sequence of steps by depressing the appropriate buttons. A green light and buzzer signify a correct response; a red light indicates an incorrect choice.

Physical Characteristics: Weight: 6 pounds; Width: 14 inches; Depth: 10 inches; Height: Unknown.

Power Requirements: Unknown

Reference: None



SUBJECT-MATTER TRAINER (SMT)

Date: 1955

Source: Not commercially available

Cost: Unknown

Originator: G. C. Besnard and L. J. Briggs, Personnel and Training Research Center, United States Air Force, and E. S. Walker, Hughes Aircraft Company

History: Functional specifications prepared by L. J. Briggs and developed under contract for the Air Force by Hughes Aircraft Company as one of many efforts to devise and evaluate principles, devices, and techniques for the effective training of Air Force armament system mechanics.

Operation: Questions are displayed to a trainee in the small window at the left of the sloping panel. A set of 20 possible answers is available on the panel to the right. Next to each answer alternative is a button that may be pressed if the particular item is selected as the trainee' s answer. A "right" indication is given by a small green light to the left of each response alternative. A "wrong" indication is given by the red bulb visible in the top left corner of the sloping panel. If desired, either a "right" or "wrong" answer may be accompanied by the sounding of a buzzer. A new question is obtained by pressing the button in the lower left corner. The SMT has five modes of operation. The "Quiz Mode." The student quizzes the machine about the correct answer by pressing the button near the top on the left side of the device. The correct choice is indicated by a green light that appears next to the correct response. In the "Modified Quiz Mode," the trainee selects an answer which he believes to be correct and presses the button next to his choice. If successful, a green light appears and the trainee may advance to the next question. If incorrect, a "wrong" indication will be given and simultaneously a green light will appear beside the correct answer. The next question cannot be obtained until the correct answer button is pressed, informing the machine that its correction has been noted. In the "Practice Mode," the student again chooses the answer. If correct, the green light glows to the left of the chosen answer and a new question may be obtained. If incorrect, the red light flashes. The device does not indicate the correct answer. The student is required to make successive choices until he finds the correct answer. In the "Single-Try Mode," the student is allowed only one answer for each question. The device will indicate the correctness or incorrectness of his answer, but in either case the student must immediately go on to the next question. The "Paced-Practice Mode" can be made to correspond to any of the previously described modes of operation, except that an instructor or experimenter can externally control the duration of each item presentation. The "Test Mode" corresponds to the Single-Try Mode, but no correct-incorrect information is given. In all modes, a tally register records the total number of response attempts and another register records the number of wrong responses.

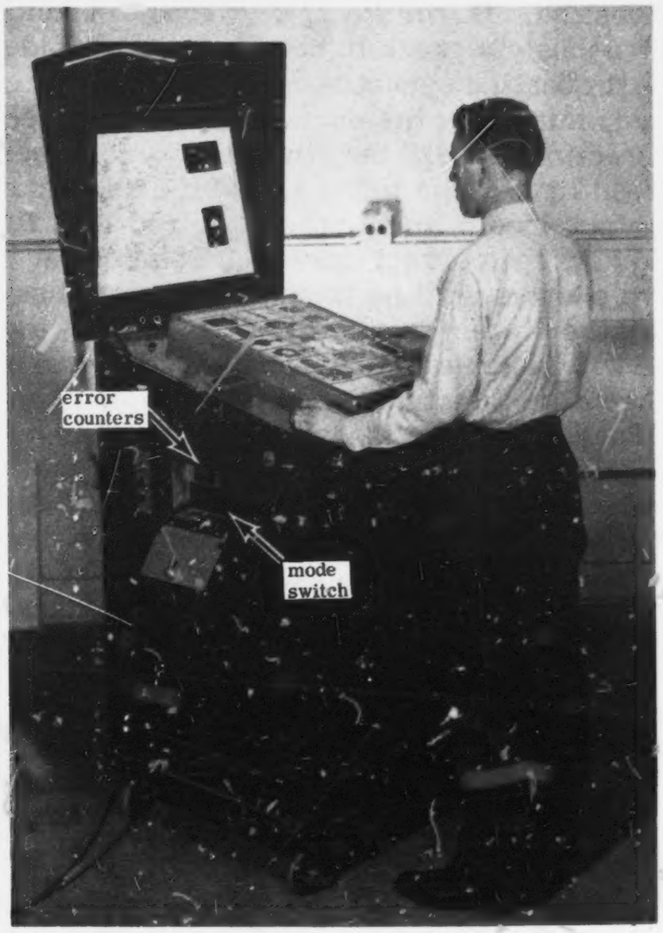
Uses: To teach serial procedures, symbols, and nomenclature, and limited problem-solving skills. Though intended and designed as a research tool, the SMT has been used informally with good success at the New York and Washington Air Defense Sectors to provide self-instructional opportunities for operational personnel.

Physical Characteristics: Weight: 150 pounds; Width: 25 inches; Depth: 30 inches; Height: 47-1/2 inches

Power Requirements: 115 volts, 60 cycles

References:

1. Briggs, L. J., "Two Self-Instructional Devices," Psychological Reports, 4, pp 671-676, 1958.
2. Irion, A.L. and L. J. Briggs, "Learning Task and Mode of Operation Variables in Use of the Subject-Matter Trainer," Technical Report AFPTRC-TR-57-8, Air Force Personnel and Training Research Center, Lowry Air Force Base, Colorado, ASTIA Document No. AD 134252, October 1957.
3. Besnard, G.G., L. J. Briggs, G. A. Mursch, and E. S. Walker, "Development of the Subject-Matter Trainer," Technical Memorandum, Armament Systems Personnel Research Laboratory, AFPTRC, Lowry Air Force Base, Colorado, ASPRL-TM-55-7, March 1955.
4. Besnard, G.G., L. J. Briggs, and E. S. Walker, "The Improved Subject-Matter Trainer," Technical Memorandum, Armament Systems Personnel Research Laboratory, AFPTRC, Lowry Air Force Base, Colorado, ASPRL-TM-55-11, April 1955.
5. Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 299-304, 1960, Reprint of Reference 1.
6. Briggs, L. J., "Teaching Machines for Training of Military Personnel in Maintenance of Electronic Equipment," Automatic Teaching: The State of the Art, E. H. Galanter (Editor), John Wiley and Sons, New York, pp 131-146, 1959.



CARD-SORTING DEVICE **Date:** 1958

Source: Not commercially available **Cost:** Unknown

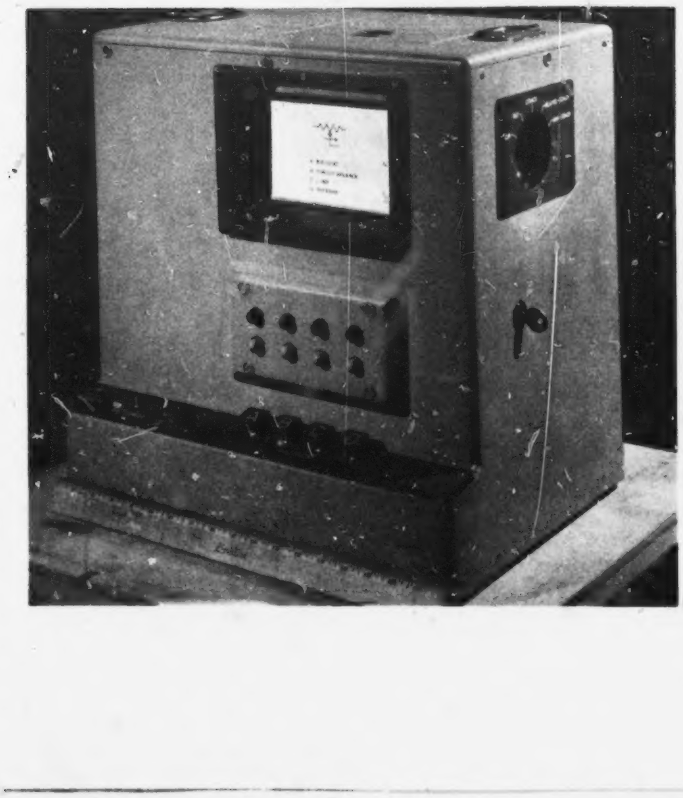
Originator: L. J. Briggs
Air Force Personnel Training Research Center
Lowry Air Force Base, Colorado

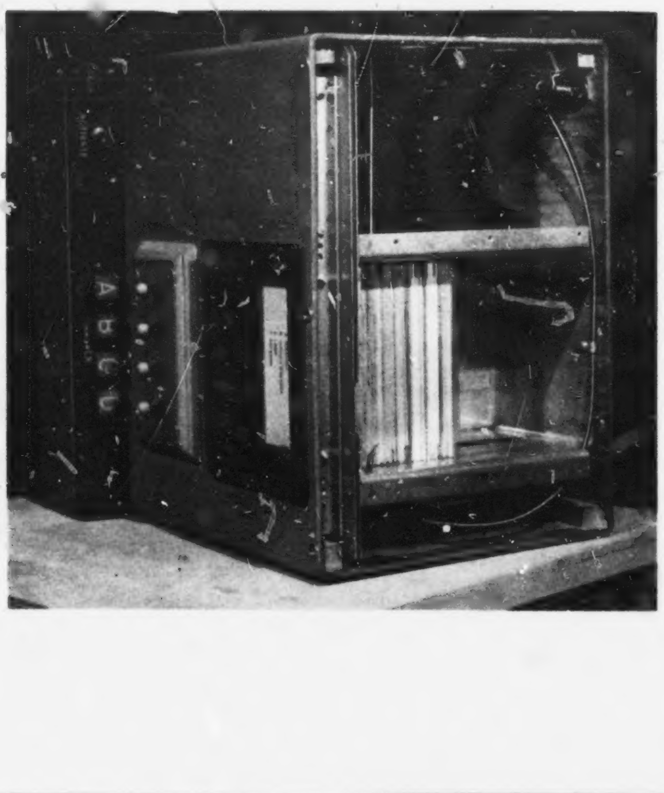
Description: This device provides practice modes almost identical to the Subject-Matter Trainer except for the Single-Try Mode and the Paced-Practice Mode. Items appear on cards which are displayed in the window. The trainee indicates his choice by pressing the appropriate answer button located below the stimulus window. A right indication is given by a small green light; a wrong indication is given by a small red light. Both appear directly above the answer button. A new question is obtained by pressing the activate button in the lower left corner. This moves the card to the side allowing the next one to be seen. If the first answer attempt was a correct one, the card is now sorted into one bin; if it was incorrect, the card goes into another bin. The material that is answered correctly need not appear again. The number of correct and incorrect answers may be easily tallied by counting the cards in the separate bins.

Physical Characteristics: Weight: 30 pounds; Width: 20 inches; Depth: 17 inches; Height: 22 inches.

Power Requirements: 115 volts, 60 cycles

References:
1. Briggs, L. J., "Two Self-Instructional Devices," Psychological Reports, 4, pp 671-676, 1958.
2. Lumsdaine, A.A. and P. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 35-41, 302-303, 1960, Reprint of Reference 1.
3. Briggs, L. J., "Teaching Machines for Training of Military Personnel in Maintenance of Electronic Equipment," Automatic Teaching: The State of the Art, E. H. Galanter (Editor), John Wiley and Sons, New York, pp 131-146, 1959.





SEQUENTIAL PROGRAMMED ELECTRONIC EDUCATION DEVICE (SPEED)

Date: 1958

Source: Education Engineering Assoc.
3810 Pacific Coast Highway
Torrance, California

Cost: $400-$850

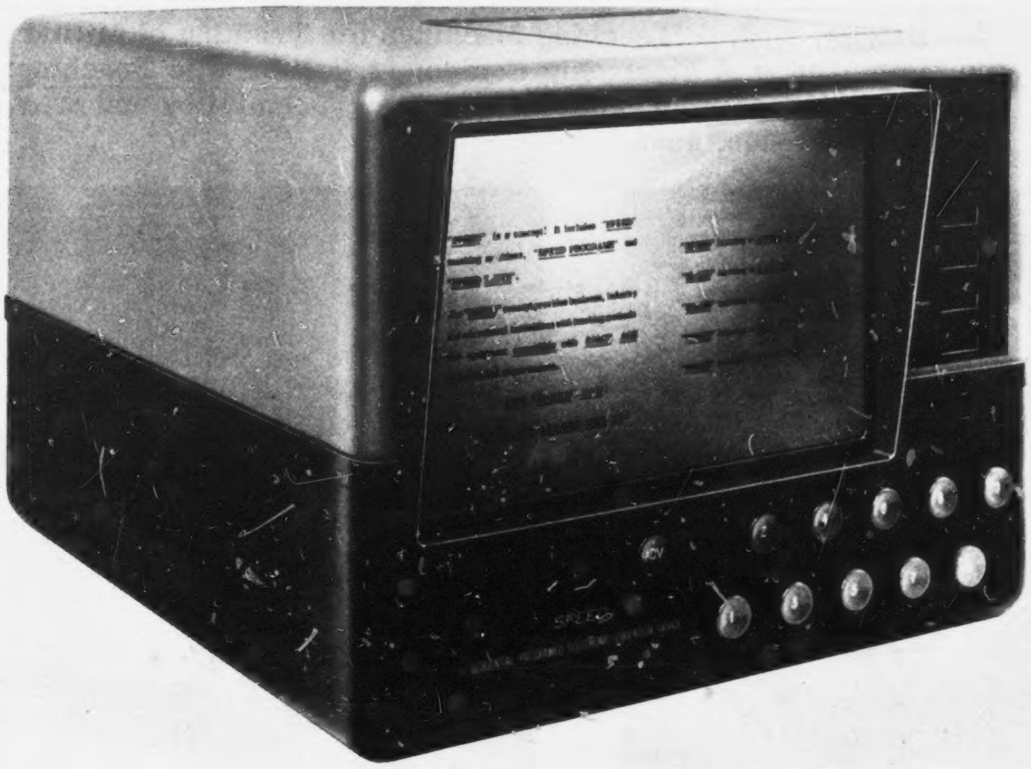
Originator: Arthur Y. Baker

Description: The instructional material is presented in increments on slides. After each unit has been presented (the length of a unit is determined by the programmer), a set of five true-false questions is asked. If all questions in the sequence are answered correctly, the student is presented the next unit. Failure to answer any one of the five questions in proper sequence recycles the machine back to the same subject material without a clue as to which question was wrong. The questions and answers are presented in random sequence. A counter measures the number of incorrect answers. "SPEED" has a "Timed Program Mode" of operation in which the instructional material is presented for a predetermined length of time. A counter keeps track of the number of times the student has to review the material. A third mode is the test mode. In this mode, the slide will automatically change when the question or questions have been answered or when the student does not answer within a predetermined length of time. The test mode has an automatic counter which keeps track of the number of correct and incorrect answers.

Physical Characteristics: Weight: 30 pounds; Width: 18 inches; Depth: 22 inches; Height: 14 inches.

Power Requirements: 115 volts, 60 cycle, 400 watts

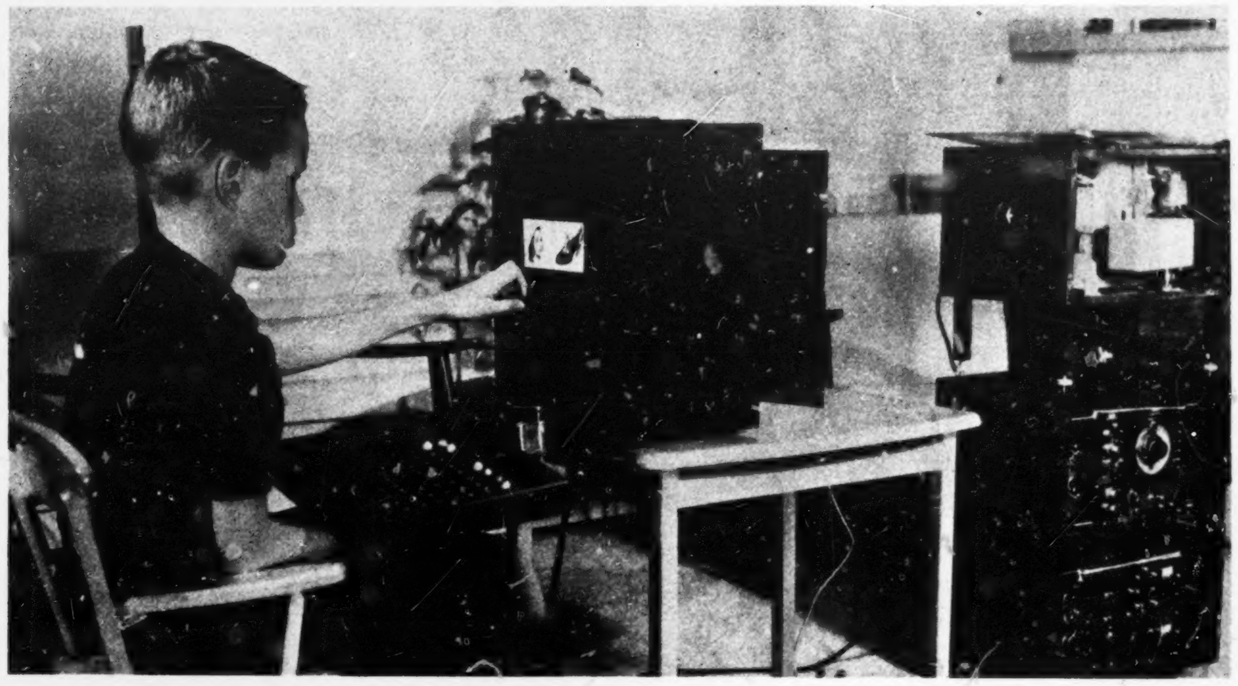
Reference: None



OSLER-FORINGER DISCRIMINATION DEVICE NO. 1231

Date:

Source:	Foringer and Company, Inc. 312 Maple Drive Rockville, Maryland
Cost:	$850-$1300
Originator:	Dr. Sonia Osler of Baltimore in conjunction with the engineering department of Foringer and Company, Inc.
History:	Conceived and developed to aid the testing and training of mentally and emotionally disturbed children using a 2-choice discrimination task.
Operation:	The material to be learned is projected on a screen from a film strip. The student indicates his answer by pressing a lever under his choice. Correct choices are automatically and promptly reinforced with a marble which falls into an open cup between the levers. Following each lever press the projector shutter is closed, and after a specified but adjustable interval the next pair of stimuli is presented. The time between lever press and the next stimulus presentation is adjustable. The pacing, then, is predetermined although the intervals can be adjusted to the performance of the trainee. Incorrect and correct responses are recorded automatically.
Uses:	This device can be used to train children to work with simple 2-choice discrimination problems, matching tasks, true-false tests, or training of preschool children. Many variations may be added to this device.
Physical Characteristics:	Weight: 83 pounds; Width: Unknown; Depth: Unknown; Height: Unknown.
Power Requirements:	117 volts, 4 amps maximum.
Reference:	None

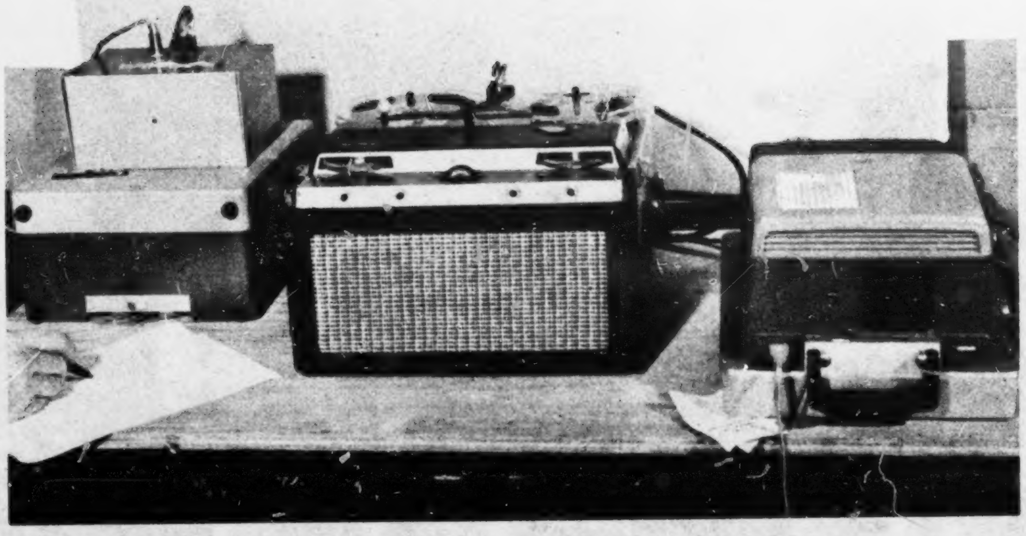


AUDIOVISUMATIC TEACHING DEVICE

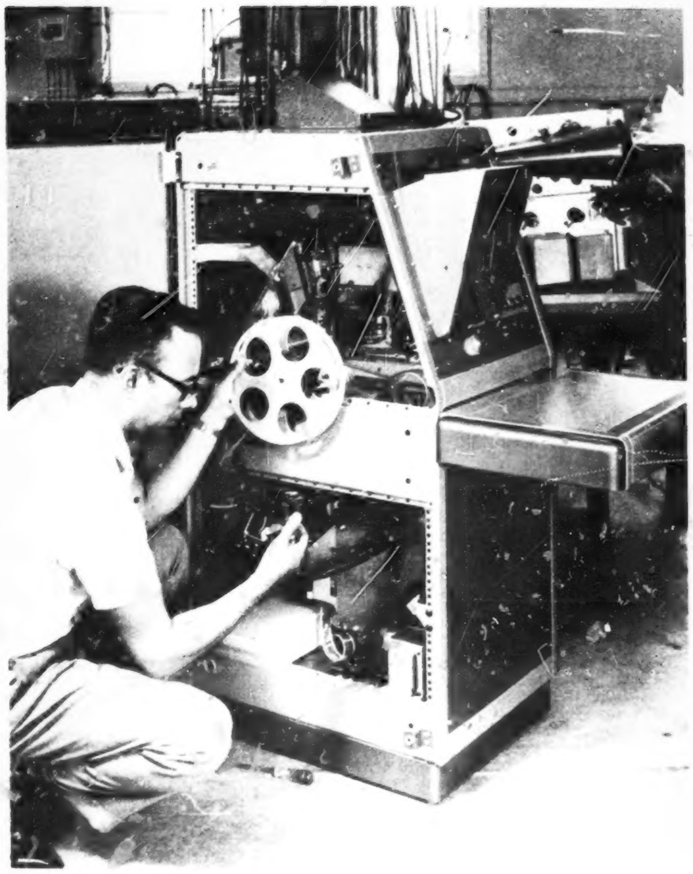
Date: 1958

Cost: $300

Source:	Unknown
Originator:	K. U. Smith University of Wisconsin Madison, Wisconsin
Description:	The instructional material is programmed on the tape recorder and slide projector. At specified intervals, if the instructor so desires, the trainee may be required to take a test over the material just learned. The audio-visumatic control unit feeds back information to the student concerning the correctness or incorrectness of his answers. This device uses Pressey's punchboard (see page 44) as the means for recording the student's answers.
Physical Characteristics:	Unknown
Power Requirements:	Unknown
Reference:	Smith, Karl U., "Audiovisumatic Teaching: A New Dimension in Education and Research," Audiovisual Communications Review, 8, No. 3, pp 85-103, May-June 1960.



CROWDER TECHNIQUE



WESTERN DESIGN AUTOTUTOR MARK I

Date: 1960

Cost: $3,000-$5,000

Source:
Western Design and Electronic Company
Division of U. S. Industries, Inc.
Santa Barbara Airport
Goleta, California

Originator:
N. A. Crowder
Western Design and Electronic Company

History: Conceived and developed by N. A. Crowder to handle intrinsically programmed materials (see page). The basis of the intrinsically programmed method is the use of the student's choice of an answer to a multiple-choice question to determine the next material to which he will be exposed. The Western Design AutoTutor is a further development of the MIPS device by L. J. Briggs (see page). The term AutoTutor has been trademarked.

Operation: The first unit of instructional material is projected on the screen. It consists of an informational paragraph and a multiple-choice question based upon it. To select the next image the trainee chooses an answer to the question and enters the number assigned to his preferred answer into the device' s selector keyboard. He then presses the view button and the device automatically locates and projects the image corresponding to his choice. If the correct answer is selected, the next image the trainee sees contains the next unit of information and the next question. If the student makes an incorrect choice, the next image he sees contains material designed to correct his error and he is directed to return to the first image and try again. If desired, the tutor can present a short motion-picture sequence. The automatic recording feature in this machine records the sequence of images viewed and the time spent viewing each image. Time is recorded cumulatively to a total of 999.9 minutes, or the elapsed time required for each choice may be recorded at the option of the user.

Uses: Virtually any kind of material that can be presented on film, including color and motion, can be presented in the AutoTutor. The AutoTutor is particularly suited to instruction on malfunction diagnosis or "troubleshooting" of complex electronic equipment or to any other situation that requires the making of sequential choices.

Physical Characteristics: Weight: 400 pounds; Width: 2 feet; Depth: 3 Feet; Height: 4-1/2 feet.

Power Requirements: 115 volts, 60-cycle external power supply.

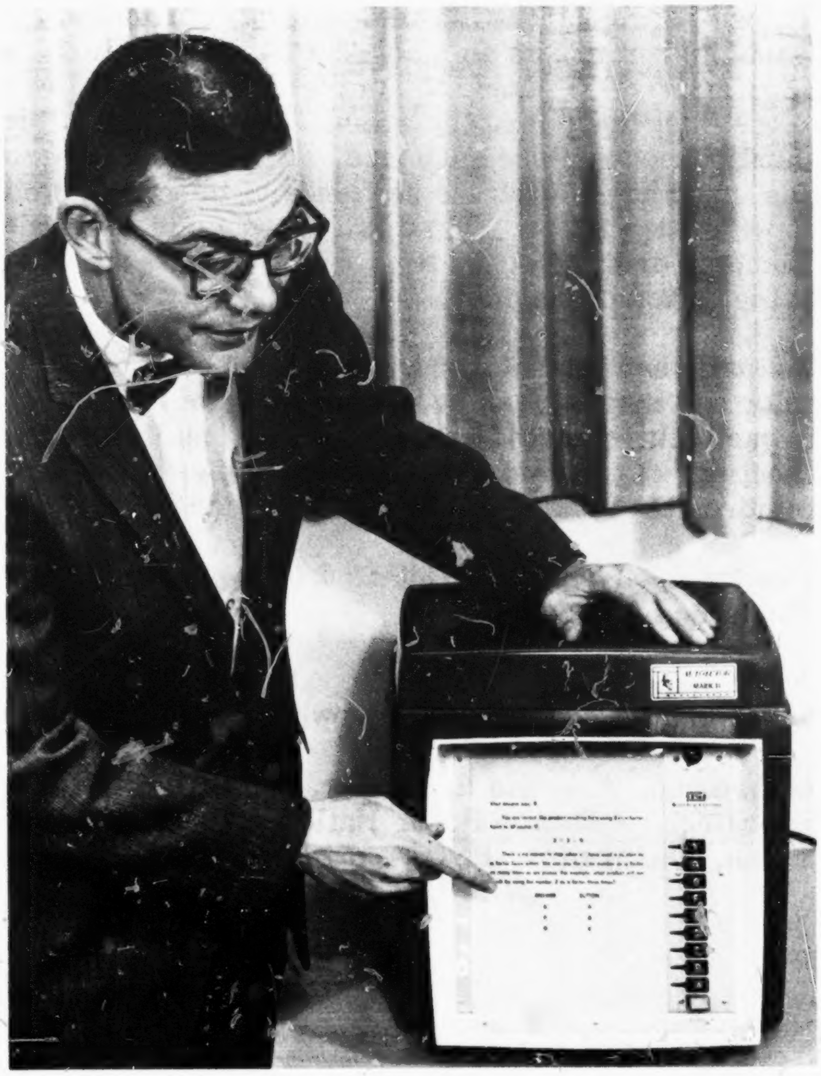
Reference: Lumsdaine, A.A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 286-298, 1960.

WESTERN DESIGN AUTOTUTOR MARK II

Date: 1960

Cost: $1100

Source:	Western Design and Electronic Company Division of U. S. Industries, Inc. Santa Barbara Airport Goleta, California
Originator:	N. A. Crowder Western Design and Electronic Company
Description:	Very similar to AutoTutor Mark I (see page 57). Differences are: this has a more limited capacity than the Mark I; it cannot show the material in a motion-picture sequence; it cannot scan for a particular frame as fast or efficiently as the Mark I. However, the other features are basically the same as the Mark I Tutor,
Physical Characteristics:	Weight: 40 pounds; Width: 15 inches; Depth: 16.75 inches; Height: 15.5 inches.
Power Requirements:	115 volts, 60 cycles, 200 watts
Reference:	None



SCRAMBLED TEXT

Date: 1958

Cost: $ 3. 95

Source:
Doubleday and Company, Inc.
Garden City, New York

Originator:
N. A. Crowder
Western Design and Electronic Company
Division of U. S. Industries, Inc.
Santa Barbara Airport
Goleta, California

Description: All of the book's pages except the first, though consecutively numbered, are arranged in a random order of content. On the first page some information is given, a problem is stated, and several alternatives are listed below. Each alternative is referenced to a particular page number. Each referenced page indicates the correctness of the student's answer, and if he is incorrect, the page selected will tell him why he is incorrect and direct him back to the problem to "try" again. Thus the final solution is not reached until each step leading to it has been successfully traversed. There is no automatic recording feature with this technique, although a measure of time could be taken.

Physical Characteristics: Weight and size of ordinary textbook.

Power Requirements: None

References:

1. Crowder, N.A., "Automatic Tutoring by Means of Intrinsic Programming," Automatic Teaching: The State of the Art, " E. H. Galanter, (Editor), John Wiley and Sons, New York, pp 109-116, 1959.
2. Lumsdaine, A.A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 286-298, 1960.
3. Crowder, N.A. and G.C. Martin, Adventures in Algebra, Doubleday and Company, Inc., Garden City, New York, 1960.
4. Hughes, R.J. and P. Pipe, Introduction to Electronics, Doubleday and Company, Inc., Garden City, New York, 1960.
5. Crowder, N.A., The Arithmetic of Computers, Western Design and Electronic Company, Division of U. S. Industries, Inc., Santa Barbara Airport, Goleta, California, 1960.
6. Goren, C.H., The Elements of Bridge, Doubleday and Company, Inc., Garden City, New York, 1960.

A sample question and appropriate responses for a correct or an incorrect answer are shown on pages 60 and 61.

Page 17

Your answer was: "No".

You are correct. As long as we are agreed on the number which will form the base of our number system, we may base the system on any number we please. A number system based on powers of 8 finds considerable use around electronic computers. This number system is called the octal system and the numbers have a basic structure as follows:

octal point

$$\ldots a_2(8^2) + a_1(8^1) + a_0(8^0). + a_{-1}(8^{-1}) + a_{=2}(8^{-2}) \ldots$$

where only the coefficients $a_2a_1a_0.a_{-1}a_{-2}$ are written explicitly, of course.

The octal number 236, for example, may be translated back to the familiar decimal system as follows:

$$\begin{aligned}\text{octal } 236 &= 2(8^2) + 3(8^1) + 6(8^0)\\ &= 2(64) + 3(8) + 6(1)\\ &= 128 + 24 + 6 = 158 \text{ decimal}\end{aligned}$$

(Since no decimal or "octal" point was shown, the right-hand digit in the number is assumed to be the units digit; that is, the coefficient of 8^0. 8^0 is, of course, equal to 1.)

What decimal number would equal octal 123?

Page 25 octal 123 = decimal 119
Page 33 octal 123 = decimal 87
Page 41 octal 123 = decimal 83

Page 41

Your answer was: "octal 123 = decimal 83".

You are correct.

$$\text{Octal } 123 = (1 \times 8^2) + (2 \times 8^1) + (3 \times 8^0)$$

$$= (1 \times 64) + (2 \times 8) + (3 \times 1) = 83 \text{ (decimal)}$$

As you can see, it is a nuisance to have to write "octal" or "decimal", etc., all the time. It is absolutely necessary, however, that we know which number system we are using; so we will add a subscript to identify the base of the number system used. Thus

octal 123 will be written 123_8

decimal 83 will be written 83_{10}

and we can write $123_8 = 83_{10}$, as we just showed above. To avoid ambiguity, the subscript number will always be a decimal number. Furthermore, if no subscript is given, the number should be assumed to be a common decimal number.

Using this notation, what decimal number would be equal to 11_2?

Page 51 $11_2 = 3_{10}$

Page 61 $11_2 = 9_{10}$

Page 69 $11_2 = 121_{10}$

Page 33

Your answer was: "octal 123 = decimal 87".

You did all right on the first digit (the 1, that is) but you forgot to translate the 23 into an octal 23. You have written

$$\text{octal } 123 = (1 \times 8^2) + 23 = 87$$

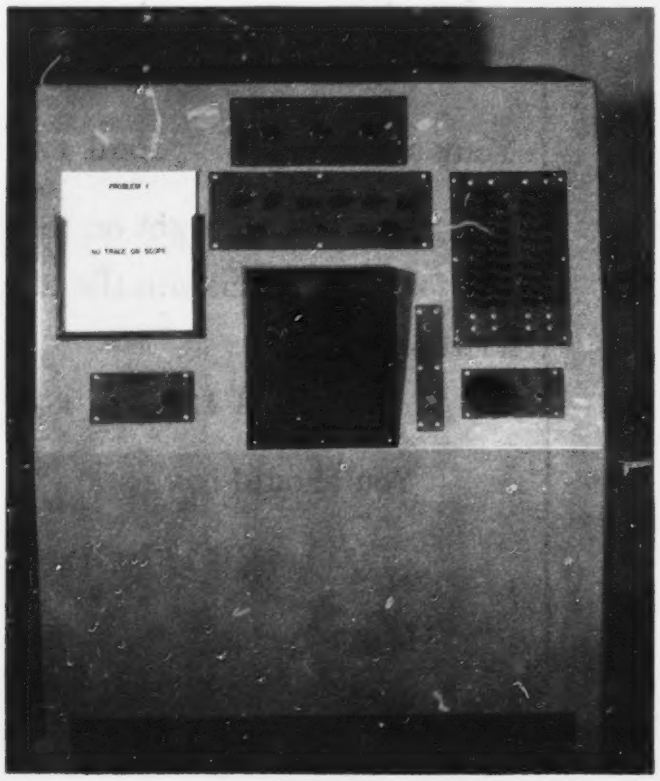
You should have

$$\text{octal } 123 = (1 \times 8^2) + (2 \times 8^1) + 3(8^0)$$

$(2 \times 8^1) + (3 \times 8^0)$ is not 23. Now return to page 17 and try again.

MULTIPURPOSE INSTRUCTIONAL PROBLEM STORAGE DEVICE (MIPS)

Source:	Not commercially available **Date:** 1955 **Cost:** Unknown
Originator:	L. J. Briggs, Air Force Personnel and Training Research Center, Lowry Air Force Base, Colorado, and E. S. Walker, Hughes Aircraft Company
Description:	The problem or diagram is displayed to the trainee on a card located on the left side of the trainer. To get more information about the problem, the trainee presses the buttons corresponding to the desired problem on the right side of the trainer. If the problem is a component-malfunction one, the trainee presses the waveform and voltage buttons. The trainee makes his response by turning six selector switches (knobs) to the answer sequence he wants. For example, if the trainee selected from the possible alternatives the answer V12564, he would set this sequence on the six selector switches accordingly. The test of the correctness of the response is made by pressing the answer button. If correct, the green light will come on, and if incorrect, the red light will come on. A new problem is obtained by pressing the code switches in the upper right hand corner. An automatic scoring feature totals the number of checks made and also totals the amount of time spent in making them.
Physical Characteristics:	Unknown
Power Requirements:	115 volts ac, 60 cycles
Reference:	Briggs, L. J., "A Trouble-Shooting Trainer for the E-4 Fire Control System," Lackland Air Force Base, Texas, Develop. Report AFPTRC TN 56-94 (ASTIA No. 098870), July 1956.



SELF-ORGANIZING SYSTEMS

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SOLARTRON AUTOMATIC KEYBOARD INSTRUCTOR (SAKI) **Date:** 1958

Source: Rheem-Califone Corporation
1020 North La Brea Avenue
Hollywood 38, California

Cost: $3,000

Originator: Gordon Pask
System Research, Ltd.
London, England

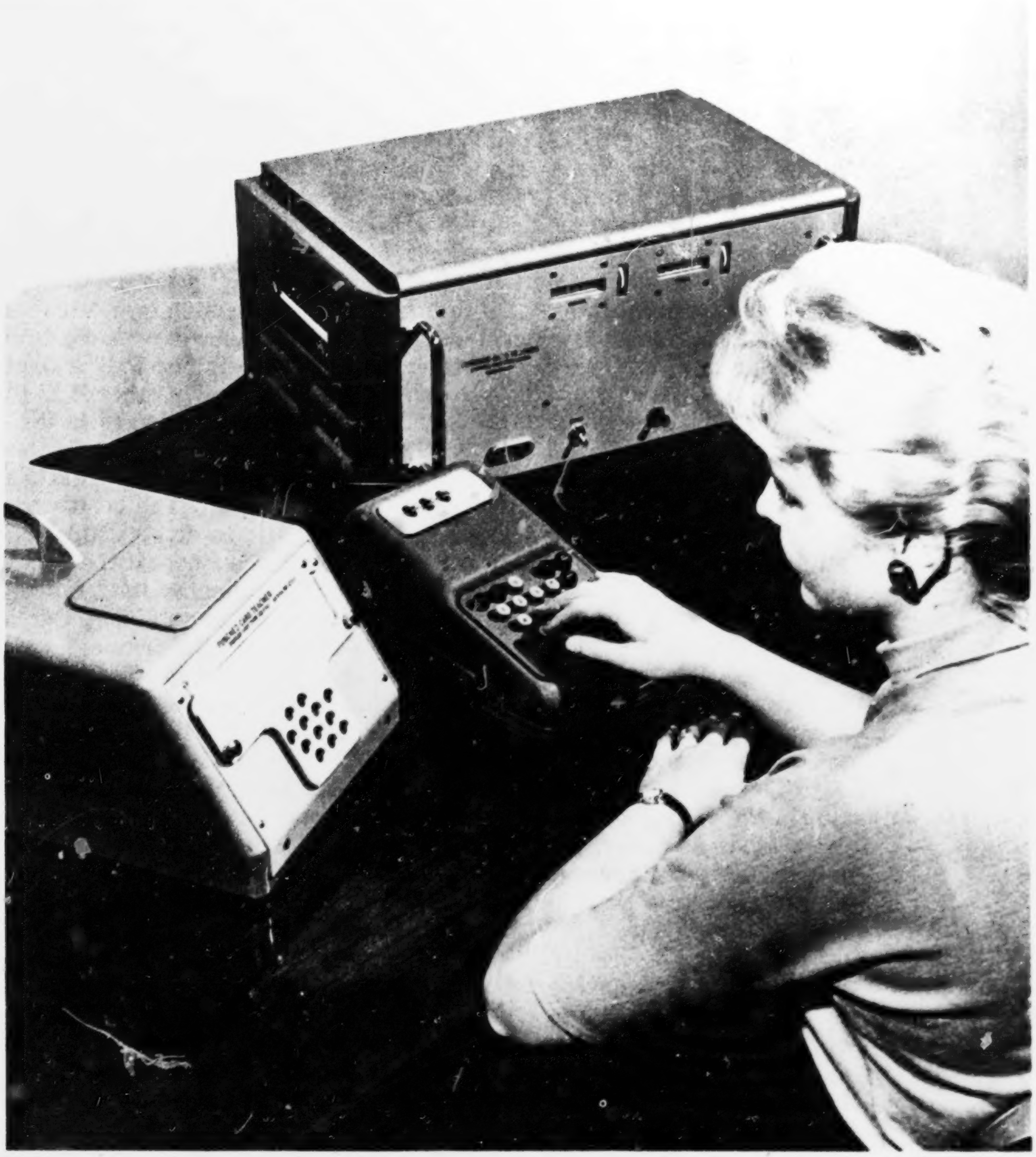
History: Prototype designed by G. Pask, System Research, Ltd., as an application of cybernetic technique to the problems of training and learning. The device illustrated here is a modification of the prototype design. It is primarily suitable for training the keypunch operators of punched card equipment.

Description: There are three major components. The keyboard corresponds to the one normally used by keypunch operators. During training it is placed within reach, but outside the trainee's field of vision. The large control unit (to the right of the trainee) contains most of the circuitry. It also contains two counters which tally the number of correct responses and the number of errors, respectively. The display unit is placed in front of the trainee. The upper half of the display is the practice card with four exercise lines. Each of the four lines consists of some 24 digits. They differ from each other in that the sequence of digits becomes progressively more difficult. When SAKI is started, a light appears behind the first digit in the first line indicating that it is to be punched into the keyboard. Simultaneously, a light appears in the prompting display below the practice card. This prompting display corresponds exactly to the keyboard layout and the light in it indicates the location of the appropriate key on the keyboard. The trainee has 4 seconds to depress the proper key. If he fails to do so within the allotted time, SAKI indicates the next digit on the line; if the proper key is depressed within the time allowed, the indicator light moves immediately to the next digit. If an error response is made, the keyboard locks until the 4-second period is over. As the trainee's skill improves, (a) the interval allowed for making the response becomes progressively shorter, and (b) the lights on the prompting display become dimmer and ultimately disappear altogether. However, SAKI makes these adjustments selectively. It allows more time on those digits to which the trainee has been responding more slowly and continues to prompt (or reintroduces the prompt) on those digits on which the trainee has made most of his mistakes. An adjustment on the control unit determines the level of proficiency which is deemed satisfactory. When this level is reached, SAKI automatically switches to the next exercise line.

Uses: SAKI is still a prototype intended to demonstrate possibilities rather than a practical teaching device. Required modifications to render it of practical value are probably minor. The principle which is here applied to the keypunch board can also be applied in similar situations such as for adding machines and typewriters.

Physical Characteristics: Weight: 133 pounds; Control Unit: 12 inches by 18 inches by 10 inches; Display Unit: 10 inches by 10 inches by 24 inches; Keyboard: 3 inches by 4 inches by 8 inches.

Power Requirements:	115 volts
Reference:	Pask, G., "Electronic Keyboard Teaching Machines," Education and Commerce, 24, pp 16-26, Sir Isaac Pitman and Sons, Ltd., London, England, July 1958. (Reprinted in Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D.C., pp 336-348, 1960.)



EUCRATES

Date: 1956

Cost: $15,000-$20,000

Source:
Solartron Electronic Group, Ltd.
Queens Road
Thames Ditton, Surrey
England

Originator:
Gordon Pask
System Research, Ltd.
London, England

History: Devised by G. Pask in response to a request by Solartron, Ltd., for a nontrivial brain to be exhibited at the Physical Society Exhibition, 1956, in London. EUCRATES II has been designed since then by C. E. G. Bailey, Solartron, Ltd., for use as a research tool.

Description: EUCRATES is not one particular device, but a category of devices to be used in conjunction with other equipment. It is fundamentally an analog simulation of a self-organizing system. Its design is based on cybernetic concepts and game theory. In its first application, EUCRATES I was linked to a jet interceptor simulator and controlled the behavior of the radar display forming part of the pilot's cockpit. Upon first turning on the radar screen the pilot trainee would see an arbitrary grouping of hostile as well as friendly targets. All targets behaved as did some real aircraft with respect to maximum speed, turning radius, etc. As the pilot trainee pressed his attack, the targets on the radar screen (controlled by EUCRATES) made their tactical countermoves. The character of these countermoves was determined by EUCRATES' experience with the characteristics of the particular pilot-trainee's tactics. Personal characteristics that did not contribute to an optimal overall strategy were continually exploited by presenting the trainee with precisely that situation which he was least well equipped to handle. Training ceased when the trainee could achieve a stalemate, i.e., successfully counter every move that EUCRATES made. Stalemate level could be set on an external control.

Uses: EUCRATES can be employed in any training situation in which instructor and trainee can be thought of as "playing a game of strategy." It acts as an instructor of infinite sensitivity who "learns" to exploit the relevant characteristics of a particular student's learning behavior.

Physical Characteristics: Variable, but fundamentally a "black box."

Power Requirements: 115 volts; 60 cycle; amps unknown, but appreciable.

References:

1. Pask, G., "A Teaching Machine for Radar Training," Automation Progress (Brit.), 2, pp 214-217, 1957.
2. Pask, G., "Artificial Organisms," General Systems: Yearbook of the Society for General Systems Research, Society for General Systems Research, Ann Arbor, Michigan, IV, pp 151-170, 1959.

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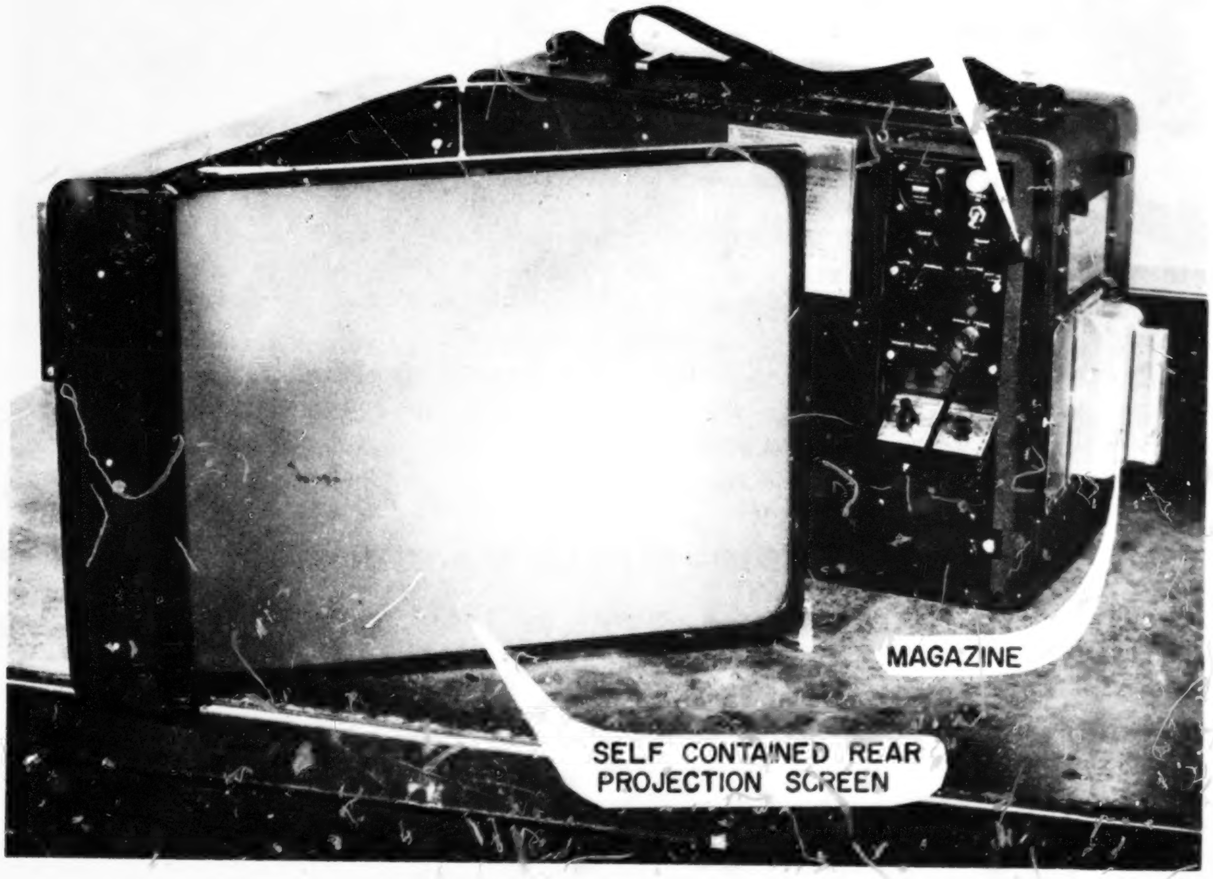
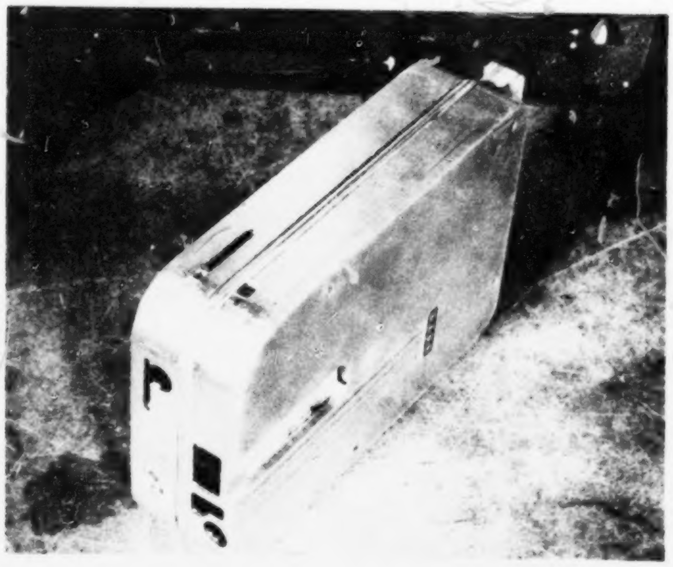
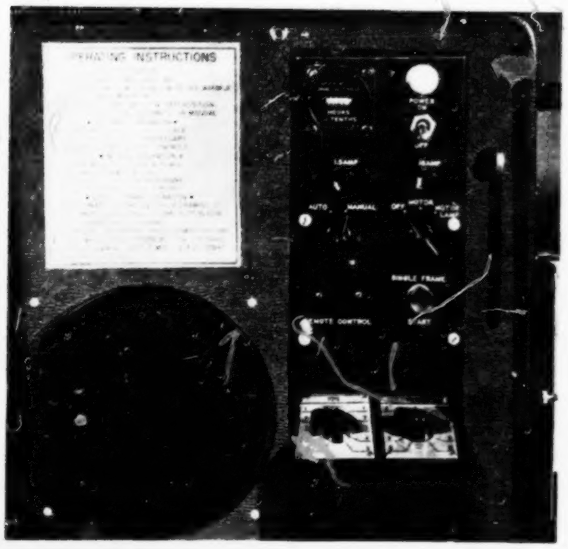
AUDIO-VISUAL MACHINES


LOCKING LEVER
MAGAZINE
SELF CONTAINED REAR PROJECTION SCREEN




OPERATING INSTRUCTIONS
POWER
LAMP
LAMP
AUTO
MANUAL
OFF
MOTOR
SINGLE FRAME
REMOTE CONTROL
START

AUTOMATIC-LOADING DAYLIGHT 16MM SOUND FILM VIEWER (HANDY-DANDY)

Source: Polan Industries, Inc.
P. O. Box 1720
Huntington 19, W. Va.

Date: 1956 **Cost:** $4,000

Originator: Polan Industries, Inc.

History: Functional specifications developed in 1951 by A. A. Lumsdaine and S. M. Roshal, Human Resources Research Laboratories, USAF. First prototype developed under contract by J. A. Maurer, Inc., in 1954. Second prototype developed by Polan Industries, Inc., in 1956.

Operation: Up to 200 feet of 16mm continuous sound film loop can be stored in each magazine. To project the film, the magazine is inserted into its slot, power is turned on, and the locking lever is moved downward. Focus, loudness, tone control, etc., can be preset. No film threading is necessary. Projector can be stop-framed on any frame; this can be preprogrammed by notching the edge of the film prior to its insertion into the magazine or the trainee can push a button when he so desires.

Uses: Originally intended as a classroom teaching aid. Inclusion of controls enabling trainee to control presentation in part renders it a true teaching machine. Particularly suitable for procedural demonstrations, eg, film demonstrates assembly of several parts and then stop-frames, trainee imitates demonstration with actual parts. Following this the next assembly sequence is shown, and so forth.

Physical Characteristics: Weight: 40 pounds; Width: 13 inches; Depth: 22 inches; Height: 16 inches.

Power Requirements: 115 volts, 60 cycles

Reference: Lumsdaine, A.A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 17-19, 1960.

AUTOMATIC STEPWISE TAPE RECORDER (ASTR)

Date: 1958

Source: Dictaphone markets the components for this device.

Cost: $750.

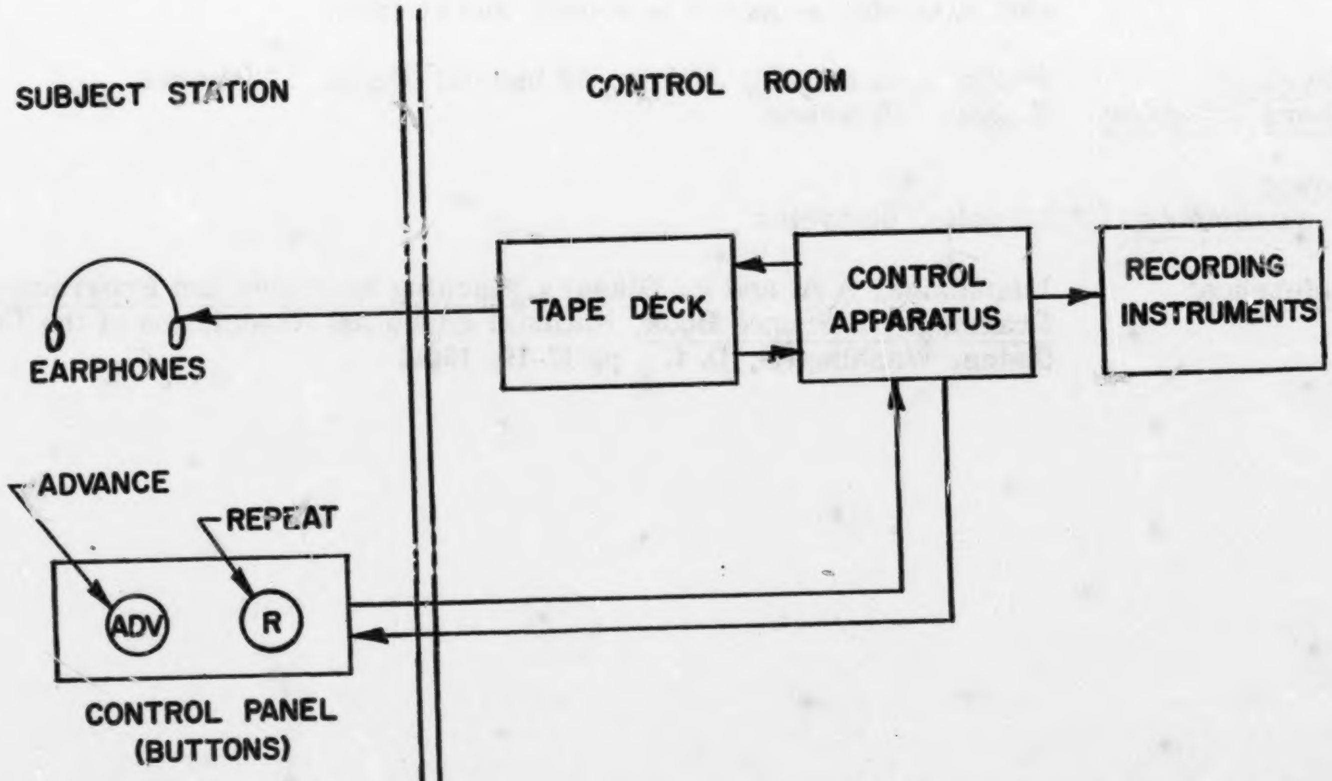
Originator: J. B. Gilpin
Earlham College
Richmond, Indiana

Description: The instructional material is presented aurally through earphones. The ASTR does not provide a "built-in" answer mode; it is mainly a stimulus presentation device. This device has two methods of "stimulus" control: "free" keying and "strict" keying. Under "free" keying, the trainee can interrupt a portion of the material being played, replay any section he wishes, etc. In "strict" keying, he cannot interrupt any portion once it has started playing.

Physical Characteristics: Weight: 30 pounds; Width: 2 feet; Depth: 2 feet; Height: 1 foot.

Power Requirements: 120-150 watts, 120 volts ac, 60 cycles.

Reference: None


SUBJECT STATION
CONTROL ROOM
EARPHONES
TAPE DECK
CONTROL APPARATUS
RECORDING INSTRUMENTS
ADVANCE
REPEAT
ADV
R
CONTROL PANEL (BUTTONS)

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CARROLL AUDIO-VISUAL AUTO-INSTRUCTIONAL DEVICE **Date:** 1960

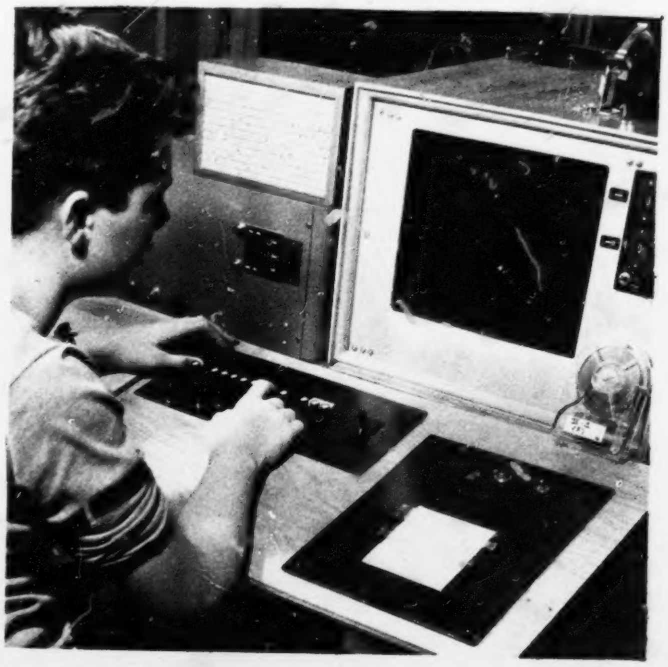
Source: Not commercially available **Cost:** Unknown

Originator: Conceived by J. B. Carroll, Harvard University, Cambridge, Massachusetts, and developed by S. K. Roby.

History: Designed as a general-purpose device for individual self-instruction in materials requiring both visual and auditory components as in foreign language instruction.

Operation: The instructional material is recorded on a 35mm film-strip loop which is projected on a ground-glass screen. A loop of magnetic tape provides the audio signals. The tape plays only a segment at a time. Each frame of film contains areas which may be separately projected, and up to three segments of tape may accompany the presentation of the several areas of any given frame. There is provision for the student to indicate his answers either by multiple choice (with up to five alternatives)or by free (constructed) responses; in the case of free responses, the learner may make his response by either writing or speaking. This device has three "modes" of operation: the "familiarization" mode presents all relevant material for each frame and allows the learner to test himself for skill or knowledge of the material on that frame while it is in position; the "learning" mode presents only questions and answers, but allows the learner to test himself, get special prompts or cues, and explore until he obtains a correct answer; in the "testing" mode, the learner is presented only with questions and answers, no exploration or prompting is permitted, and the responses are "for keeps." Thus the learner usually goes through the material of a given loop at least three times. In the familiarization and learning modes, the machine does not advance until the subject has made a correct response. The pacing of the operation is completely under the control of the learner, who manipulates a series of buttons to signal his responses and to effect advances in the machine program.

Uses: For use in foreign language instruction, the device lends itself to a wide variety of learning procedures. It allows for learning and practice of all four language skills: speaking, understanding, reading, and writing; its audio-visual nature allows the use of pictures, drawings, and charts to accompany written, printed, and spoken material.



Physical Characteristics: Size of a table-model television receiver.

Power Requirements: Unknown

Reference: None

A MICROFILM DEVICE

Date: 1961

Source: At present, not commercially available

Cost: Unknown

Originator: D. J. Klaus and A. A. Lumsdaine, American Institute for Research and A. F. Hunecke and B. Larson, DuKane Corporation, St. Charles, Illinois

Operation: The instructional material consists of a short, Skinner-type frame and includes both textual material and drawings. The student indicates his answer in one of several ways: (a) without attachments as a covert response; (b) with the tape writing device (as shown in the figure) as an overt, recorded response; or (c) using a second attachment (not pictured) - a series of buttons attached to the projector, as a multiple-choice device. The operation of the device in modes "a" and "b" requires that the student compare his answers with those provided in answer panels presented following "stimulus" panels. In the multiple-choice modes, the machine indicates the correctness of the trainee's answer and will only advance when the correct answer is given. In the overt mode, the student will not be able to anticipate which frames will call for an overt response. The instructional material is prepared and stored on 35mm film.

Physical Characteristics: Weight: 17 pounds (projector: 12 pounds, writing device: 5 pounds); Width: 14 inches, Depth: 18 inches, Height: 14 inches (projector); Width: 6 inches, Depth: 12 inches; Height: 4 inches (writing device).

Power Requirements: 110 volts, nominal projection wattage.

Reference: None

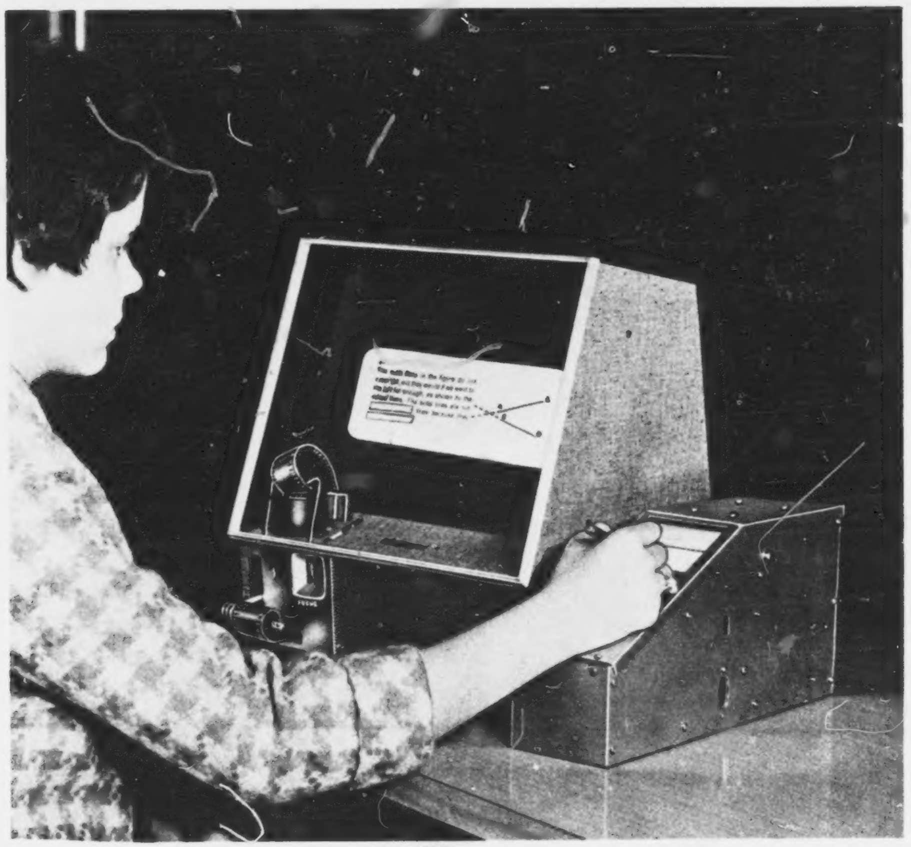
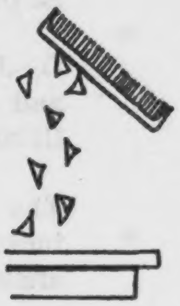


FIGURE 1

A-1



A very important discovery in physics was the mutual attraction of objects due to static electricity. If we rub a hard rubber comb with a wool cloth and hold it over bits of tissue paper, the comb will attract the paper. This attraction illustrates ______ electricity.

a-1

static

A-2

At parties, you have probably seen someone rub balloons against a wool rug to make the balloons stick to the walls or ceiling. This is another example of * ______.

a-2

static electricity

A-3

In ______ electricity, some objects will attract each other. A hard rubber comb rubbed against wool will ______ bits of tissue paper.

a-3

static
attract

VIDEOSONIC TEACHING MACHINE

Date: 1960

Source: Not commercially available

Cost: Unknown

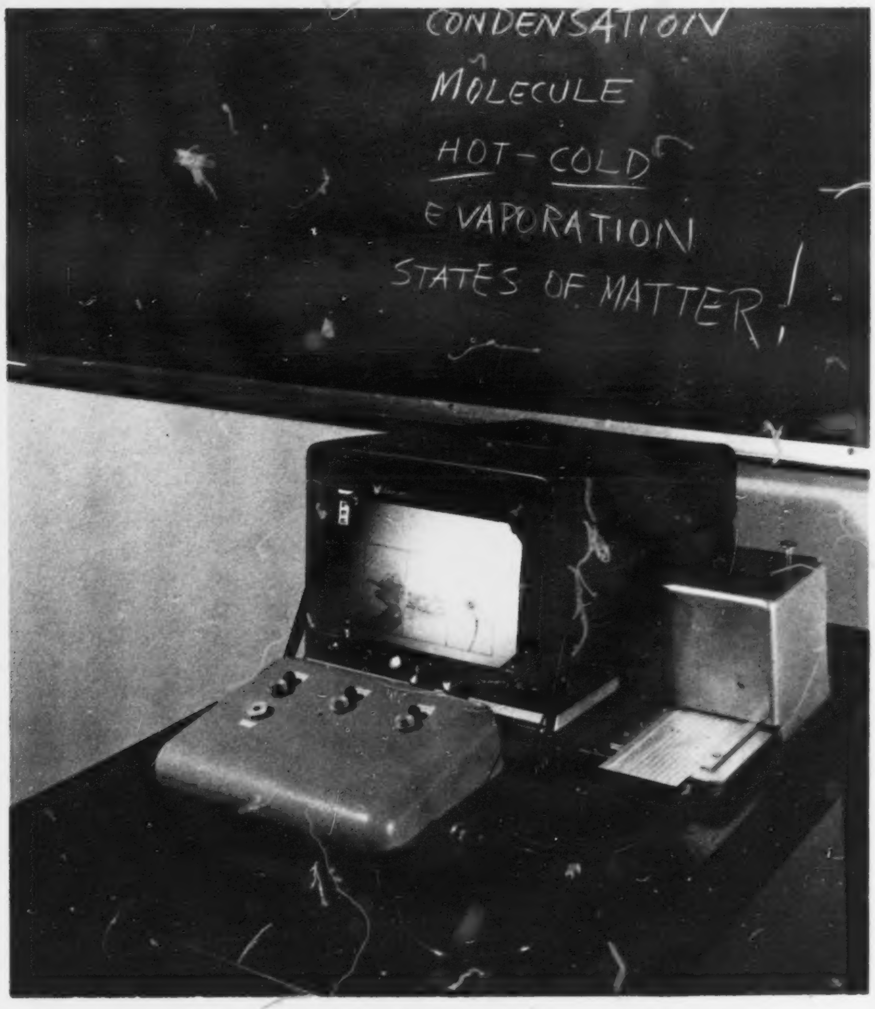
Originator: Hughes Aircraft Company
International Airport Station
Box 90904
Los Angeles 45, California

Description: The instructional material can be presented visually, aurally, or both. After each instructional step or teaching point is presented, a question or problem is given to the learner. The student selects his answer among three multiple-choice response buttons. The next unit of information will not be presented until the correct answer is provided. If the desired answer is written-completion form or oral-completion form, the slide display and aural accompaniment provide the correct answer. An associated scoring unit can keep track of the student's responses.

Physical Characteristics: Weight: 30 pounds without keyboard; Width: 12 inches; Depth: 18 inches; Height: 10 inches.

Power Requirements: 110-120 volts, 2-1/2 amps

Reference: None



LEAR OPERATIONAL ASSISTANCE AND INSTRUCTIVE DATA EQUIPMENT

Source: Not commercially available **Date:** 1960 **Cost:** Unknown

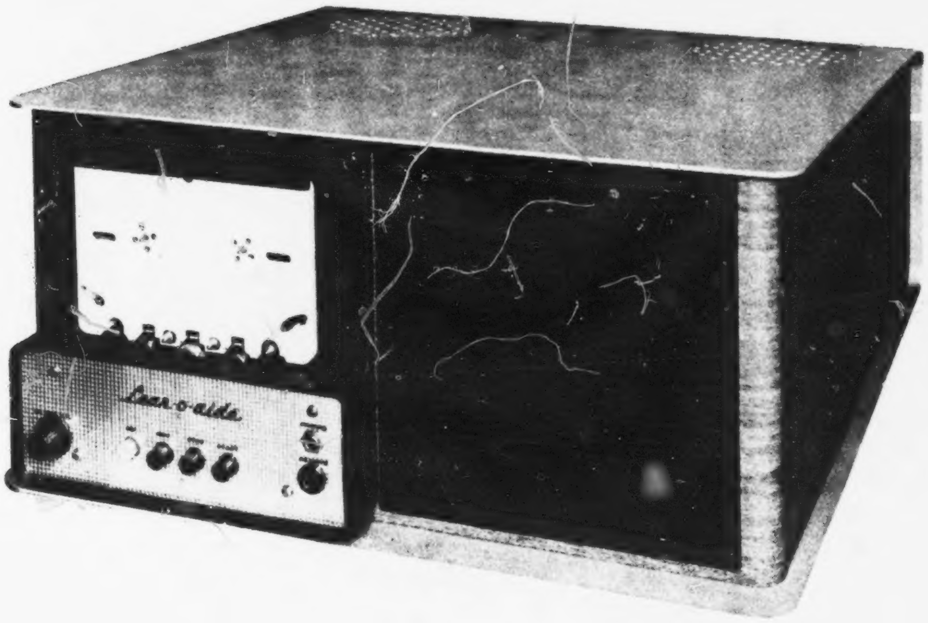
Originator:
Lear Inc.
Instrument Division
110 Ionia Avenue, N.W.
Grand Rapids 2, Michigan

Description: Exactly like the Videosonic device except that the LEAR-O-AIDE can be backed up. That is, if the trainee desires to go back and review a certain portion of the instructional material, he can.

Physical Characteristics: Screen: 9 inches by 9 inches.

Power Requirements: Unknown

Reference: None



LT-4309
(Model C)

THE T-3 EDUCATOR

Date: 1961

Cost: Unknown

Source:
All American Engineering Company
DuPont Airport
Wilmington, Delaware

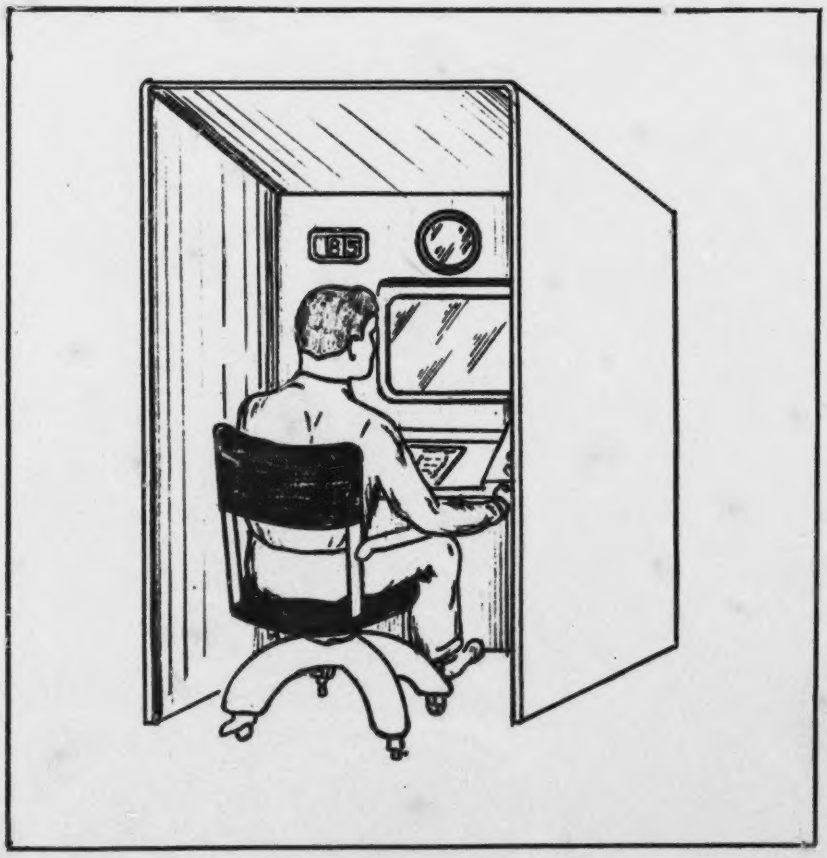
Originator: All American Engineering Company

Description: The T-3 Educator consists of a console in an enclosure for the use of one person, within which is given a programmed visual and aural presentation of the instructional material by means of a sound motion picture. The student operates the educator by means of console-mounted controls. The mounted controls permit either the lesson or the test to be presented. The tests are multiple choice. In answer to a question the student selects what he considers the appropriate button. Signal lights indicate the correctness of the trainee's answer. At the end of the test, the student's score appears in the window of the console. If desired, the trainee can recycle the complete presentation of the test.

Physical Characteristics: Unknown

Power Requirements: Unknown

Reference: None



PRECEDING PAGE BLANK—NOT FILMED

DIGITAL COMPUTERS
AS
TEACHING MACHINES

PRECEDING PAGE BLANK-NOT FILMED

DIGITAL COMPUTERS IN SOPHISTICATED TEACHING SYSTEMS

The digital computer per se is not a teaching machine any more than a human brain is a teacher. Where it is used in the teaching context it is only a component albeit the central component of a highly sophisticated instructional system. It serves the function of accepting and storing assorted information in digital form, processing it according to stored instructions, and making decisions on the basis of the processed information which guide the behavior of the instructional system. Thus it is an analog to certain ones of the higher mental functions of the human teacher. Unlike the human teacher, however, the digital computer can accept simultaneously, or almost simultaneously, a vast amount of information and process it with enormous rapidity.

The use of the modern digital computer introduces possibilities for highly flexible and complex programming that could not be achieved in any other way and that are not yet very well understood. The technology of this approach is still only in its earliest infancy. Beginning with Rath, Anderson, and Brainerd in 1958, several investigators have sought to explore the potential of the digital computer. In this quest, widely differing types of computer-linked systems have been set up. Not only have there been differences in the computer types and models as well as their programming, but also the instructional displays and the student-response-accepting devices have differed. All systems in existence so far have been experimental and designed for the investigator' s particular purpose. Consequently, illustrations in this section are only of general informational value; they have no specific significance.

IBM 650 TEACHING MACHINE

Date: 1960

Source: Not commercially available

Cost: Unknown

Originator: G. J. Rath, N. S. Anderson, and R. C. Brainerd, IBM Research Center, International Business Machine Corporation, P. O. Box 218, Yorktown Heights, New York

Description: An IBM general-purpose digital computer with a typewriter input and output was used to teach binary arithmetic. The computer program included these features:

(1) The student was required to construct his answers by typing them into the machine.
(2) The machine corrected the answer digit by digit.
(3) Errors were forestalled in certain cases, as when the student tried to make the answer too long. Here the machine said "right" before an error could be made by the student.
(4) The machine allowed for individual differences in skill level and rate.

The computer program included a "drop-out" feature which allowed the student to skip certain problems if for some time previously no errors had been made.

Physical Characteristics: As for IBM 650 computer.

Power Requirements: As for IBM 650 computer.

References:

1. Lumsdaine, A.A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 676, 1960.
2. Rath, G.J., N. S. Anderson, and R. C. Brainerd, "The IBM Research Center Teaching Machine Project," Automatic Teaching: The State of the Art, E. Galanter (Editor), John Wiley and Sons, Inc., New York, pp 117-130, 1959.

G-15 COMPUTER TEACHING MACHINE **Date:** 1959

Source: Not commercially available **Cost:** Unknown

Originator: J. E. Coulson and H. F. Silberman
System Development Corporation
Santa Monica, California

Description: This teaching machine consists largely of three parts: the G-15 digital computer, a random-access 35mm slide projector with screen, and an automatic electric typewriter. The computer carries on the programming function, the slide projector presents the instructional material, and the trainee indicates his response on the automatic electric typewriter. Also, information about the adequacy of his performance is conveyed to the student by means of the typewriter. The projector contains "drums" which enable any one of 800 slides to be presented in any random order with a very brief random access time. The trainee has a choice of several answers with each slide presented. He indicates his answer by typing out the coded number next to his choice on the automatic electric typewriter. He may change his answer as often as he wants prior to signaling his commitment. However, once he has decided on his final answer, the electric typewriter types out the student's answer to confirm it, and then indicates the adequacy of the answer. If he is incorrect, he must try again. If he is correct, he goes on to the next problem. Depending on the character of his performance record, the student may be presented with branching sequences or he may be "skipped ahead." When the student has completed the instructional unit, the computer types out a summary record of the student's performance

Physical Characteristics: System requires approximately 144 square feet of floor space.

Power Requirements: 115 volts, 60 cycle.

Reference: Unknown.

RCA TEACHING MACHINE RESEARCH FACILITY

Date: 1959-60

Source: Not commercially available

Cost: Unknown

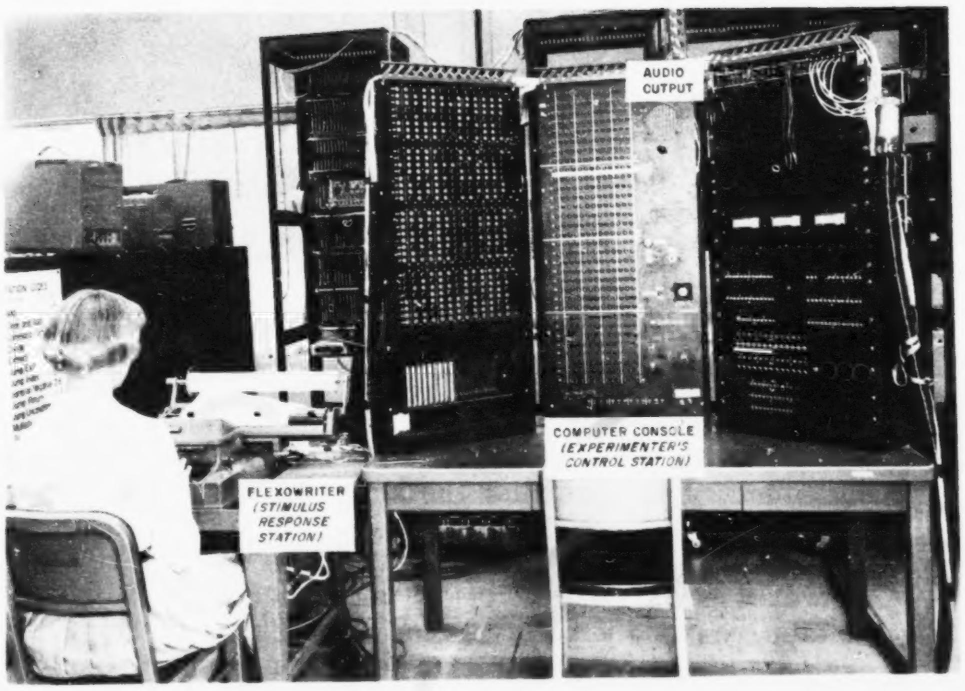
Originator:
E. I. Gavurin
RCA Teaching Machine Research Facility
49 Overlook Road
Arlington, Massachusetts

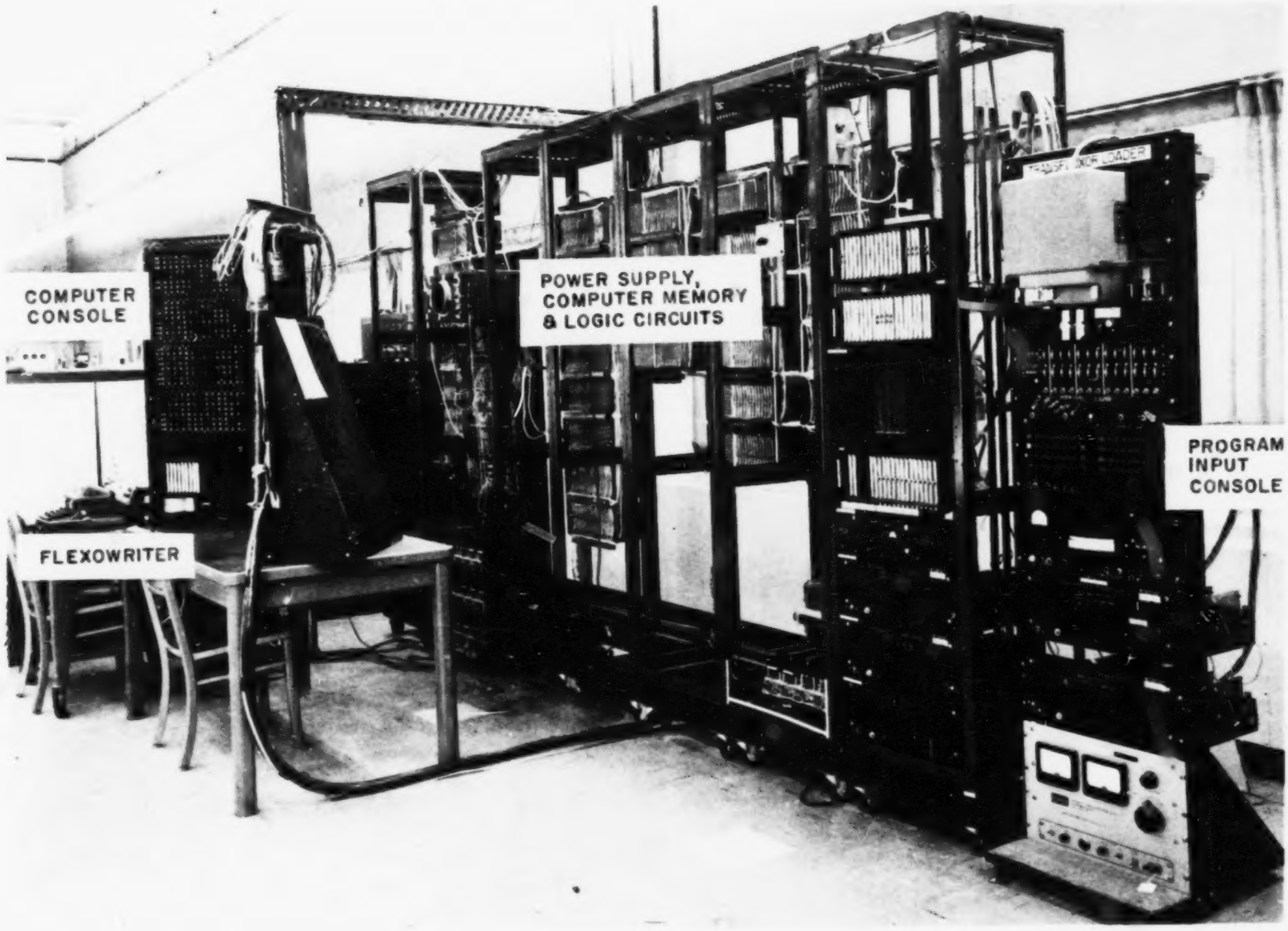
Description: The instructional material can be presented either visually or audially. In visual presentation the instructional material is typed automatically on the flexowriter. In audio presentation the instructional material is presented over the audio-output station. The trainee' s answer is made on the flexowriter, which can be utilized for constructed, multiple-choice, or true-false answers. This facility has marked flexibility so that various types of verbal rewards may be presented and various schedules of reinforcement (reward) and repetition may be invoked. Pacing may be placed under the control of the student or the experimenter. Scoring is completely automatic; either recall or recognition responses may be required, and any combination of the above may be used.

Physical Characteristics: Unknown

Power Requirements: 115 volts, 400 cycle.

Reference: None


AUDIO OUTPUT
COMPUTER CONSOLE (EXPERIMENTER'S CONTROL STATION)
FLEXOWRITER (STIMULUS RESPONSE STATION)


COMPUTER CONSOLE
POWER SUPPLY, COMPUTER MEMORY & LOGIC CIRCUITS
TRANSFORMER LOADER
PROGRAM INPUT CONSOLE
FLEXOWRITER

ADAPTIVE TEACHING MACHINE (RESEARCH FACILITY)

Date: 1960

Source: Not commercially available

Cost: Unknown

Originator:
Applied Research Laboratory
University of Arizona
Tucson 25, Arizona

History: Developed as a flexible research tool for investigations of programming techniques, training presentation factors, and student response factors. The Research Facility was designed to provide both aural and visual presentation of materials with random access to any part of the program.

Operation:

I. Student Station

The problem or concept is presented via a 35mm slide-film in the window at the top. A magnetic tape cartridge permits occasional spoken commentary or recording the student's response. Responses may be either of a multiple-choice type or demand active recall. The recognition mode requires the trainee to press one of five buttons below the answer window. Active recall mode requires the student to write or dictate (respond vocally). The student may be required either to self-evaluate his answer against a correct one or to respond to questions about his answer. The student may type out his answer. A test mode is incorporated in this machine. Thirty minutes of recorded instruction per magnetic tape cartridge side are possible. Cartridges may be sequenced indefinitely. Student paces his own material.

II. Master Control Unit Programming Panel

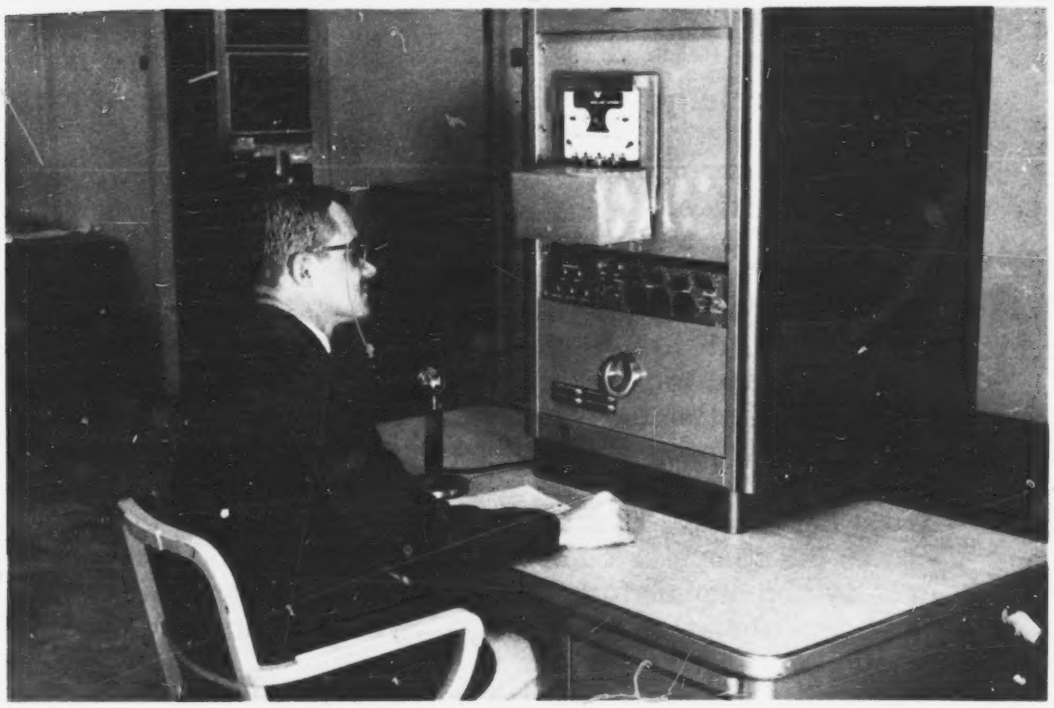
Permits generation of programs and subsequent modification of such programs as dictated by the design of an experiment, the experience gained from pretesting programs or by upgrading of course content.

Uses: This device was conceived and developed to investigate and determine appropriate subject matter, philosophy of presentation, and mode of response by students. "It is hoped that the device will enable testing of a number of hypotheses proposed in learning theory and contribute to the ability to measure psychological attributes such as learning ability, subject background, tendency to commit random errors, recall ability in time, and other characteristics of student subjects."

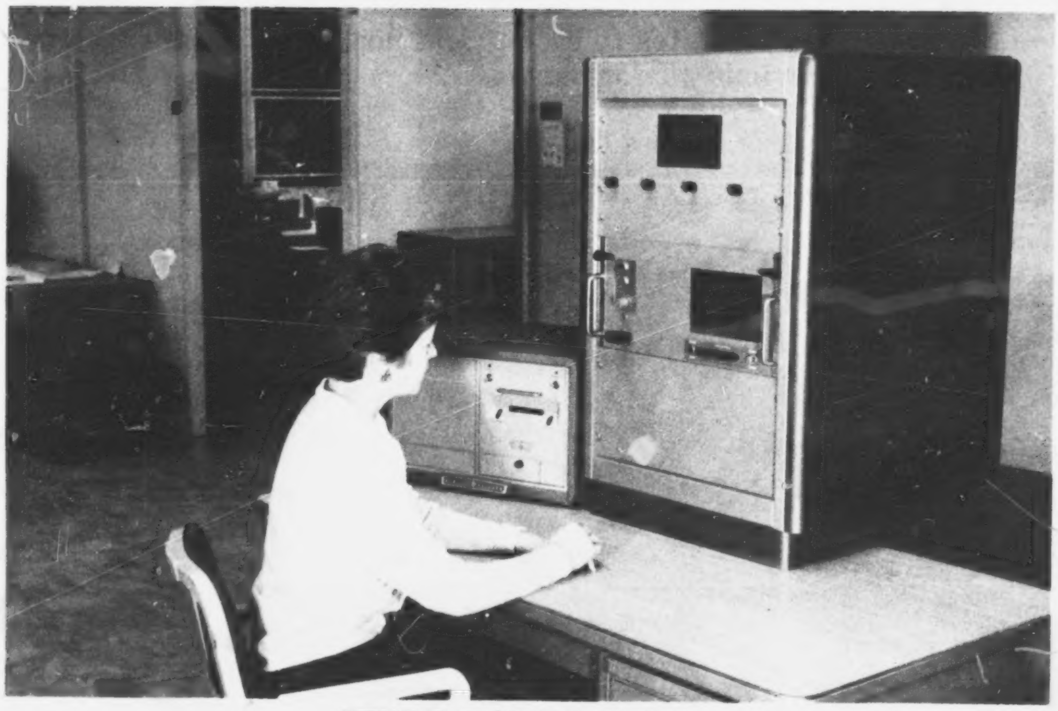
Physical Characteristics: Weight: 100 pounds; Width: 2 feet; Depth: 2 feet; Height: 3 feet with a commercial printer which is 18 inches wide, 10 inches high, and 15 inches deep.

Power Requirements: Normal current from 110 volt ac outlet.

Reference: Baldwin, Howard A., "An Adaptive Teaching Machine Concept," Paper presented at the 68th Annual Meeting of the American Society for Engineering Education, Purdue University, June 20, 1960.



INSTRUCTOR'S PANEL



STUDENT'S CONSOLE

LGP-30 COMPUTER TEACHING MACHINE

Date: 1960

Source: Not commercially available

Cost: Unknown

Originator:
Bolt, Beranek, and Newman, Inc.
50 Moulton Street
Cambridge 38, Massachusetts

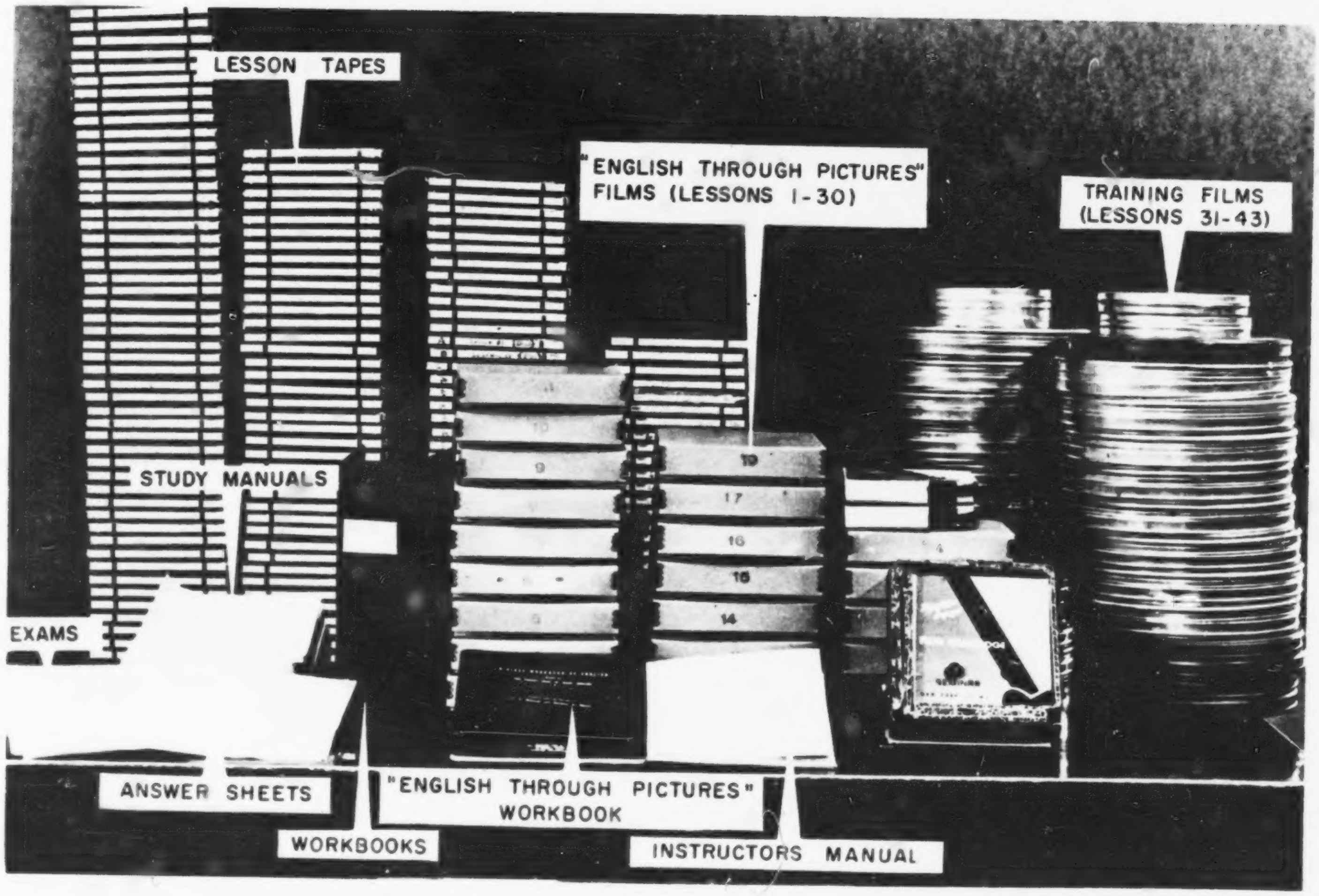
Description: This machine contains two parts: the LGP-30 computer and a flexowriter. The flexowriter acts as the input-output station (the instructional material is presented on it and the student types out his answer on it). To distinguish between student-typed and computer-typed material, the program changes the ribbon to red prior to each computer print-out. There is one exception to this: if the score of the student drops below zero, it appears in red. The lesson is begun by typing a "K" to the computer control section. The computer types out the introductory and explanatory material for the student and indicates that he can begin whenever he is ready. When the student is ready he types a particular character (given in the preliminary instructions); the computer types out the first question, repositions the typewriter carriage, and waits for the student's answer. The student's reply is either correct or incorrect. There may be more than one correct answer, but there are no degrees of correctness. If the reply is perfect the first time, that question is deleted by the computer from the list of questions to be asked during the lesson. If the reply is incorrect, the computer indicates it is incorrect and asks the student whether or not he desires to try again. If the student responds affirmatively, the sequence is repeated. If he declines to try again, the computer types out the right answer and indicates that the student is to copy it correctly. The computer will not move on to the next question until the student copies the correct answer. The questions that are not answered correctly the first time are repeated more often than the other questions. This computer also indicates to the student how well he is doing in comparison to his previous performance.

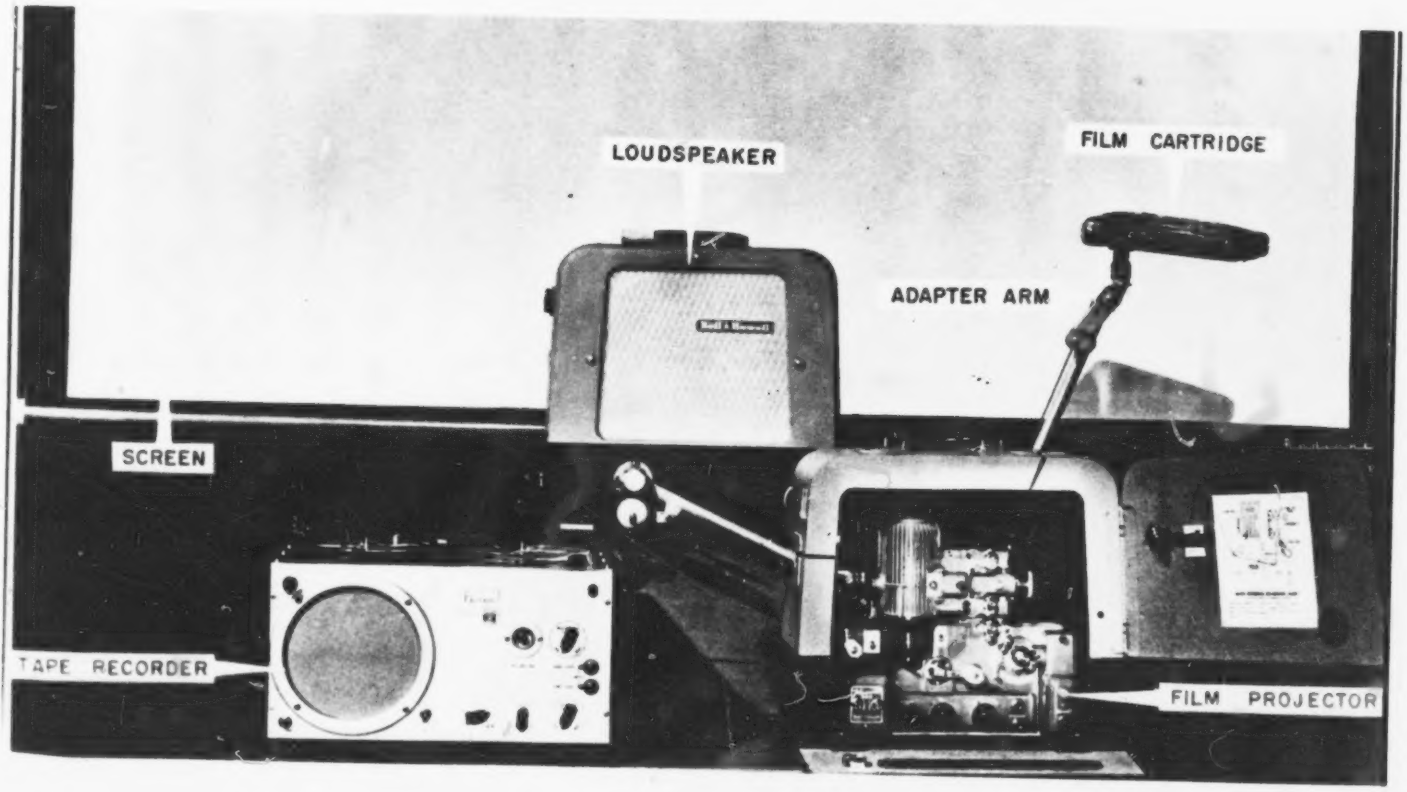
Physical Characteristics: Unknown

Power Requirements: The same as the basic LGP-30 computer

Reference: None

MISCELLANEOUS DEVICES


LESSON TAPES
"ENGLISH THROUGH PICTURES" FILMS (LESSONS 1-30)
TRAINING FILMS (LESSONS 31-43)
STUDY MANUALS
EXAMS
ANSWER SHEETS
"ENGLISH THROUGH PICTURES" WORKBOOK
WORKBOOKS
INSTRUCTORS MANUAL


LOUDSPEAKER
FILM CARTRIDGE
ADAPTER ARM
SCREEN
TAPE RECORDER
FILM PROJECTOR

PROTOTYPE INSTRUCTOR-FREE PACKAGE COURSE

Date: 1954

Source: Not commercially available

Cost: Unknown

Originator: F. F. Kopstein, J. O. Cook, W. Potter, and H. H. Shettel
Training Aids Research Laboratory
Air Force Personnel Training Research Center
Chanute Air Force Base, Illinois

History: Developed in response to an unusual and acute problem of teaching English as a foreign language to prospective allied pilot trainees who had little or no knowledge of it. Preliminary versions were designed by Kopstein in 1952. Complete course was designed and prepared by above-listed originators in 1954. "American Aviation English" is known to have been used successfully in France, Italy, Spain, and Germany. Master copies of the materials were deposited at the Anthropological Archives, Indiana University, Bloomington, Indiana.

Description: Introduces the concept of "educational engineering" and design of relatively instructor free teaching systems. These systems can be so designed as to (a) employ the latest appropriate technology and learning principles, (b) produce trainees having uniformly high proficiency, and (c) fit situational requirements or restrictions. For example, the course whose materials and implements are illustrated was designed so that it could be applied wherever instruction in the English language was needed, regardless of the native language of the students. It was also designed so that it could be administered by personnel who had had little or no previous experience in teaching. Illustrations show the physical materials for approximately 253 hours of instruction and the implements for their presentation.

Uses: Uses for this type of automated course are virtually unlimited.

Physical Characteristics: As shown

Power Requirements: 110 volts ac, 60 cycles

Reference: Lumsdaine, A.A., "Partial and More Complete Automation of Teaching in Group and Individual Learning Situations," Automatic Teaching: The State of the Art, E. Galanter (Editor), Wiley and Sons, Inc., New York, pp 147-166, 1959.

GENERALIZED ELECTRONIC TROUBLE-SHOOTING TRAINER (GETS)

Source: Not commercially available **Date:** 1956 **Cost:** Unknown

Originator: N. D. Warren, D. W. Atkins, J. S. Ford, and H. L. Wolbers
Psychological Services Inc.
909 West Jefferson Boulevard
Los Angeles 7, California

History: Developed for the Air Force by Warren, Atkins, Ford, and Wolbers as a training device to investigate and teach trouble-shooting procedures.

Operation: A malfunction can be introduced into any one of the 30 "black box" components on the face of the trainer. The row of indicators across the top are used by the trainee to determine whether a malfunction exists. If it does, the test-probe and associated "test instruments" across the bottom can be used to (a) insert signals or (b) obtain readings from several test points (hidden by the "black boxes"). All "malfunctions" consist of an open circuit-breaker in a black box. Identification of a particular black box is confirmed or disconfirmed as soon as the circuit breaker is examined. If more than one box is involved, some symptoms persist on the indicators across the top of the panel.

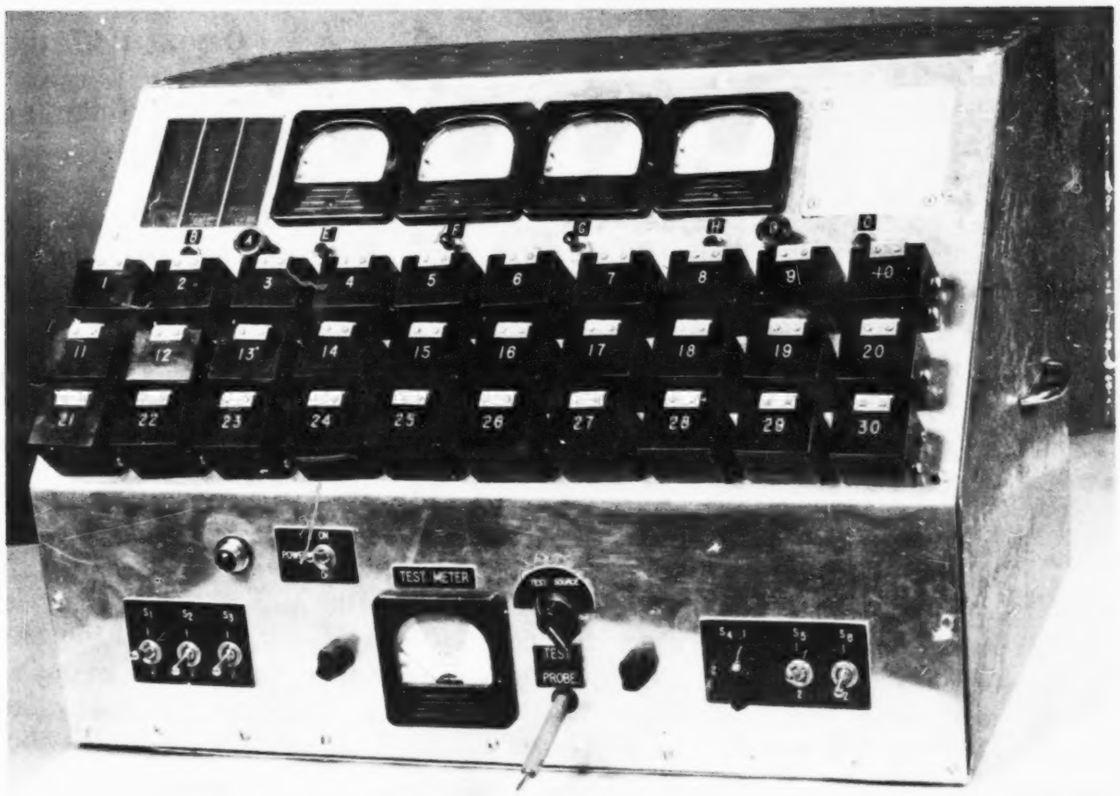
Uses: The GETS trainer was devised as an integral part of a carefully designed course. While the course outline introduces progressively more complex circuits and data-flow relationships, the GETS trainer could be adjusted to provide individual practice in trouble-shooting these circuits.

Physical Characteristics: Weight: 20 pounds; Width: 21 inches; Depth: 12 inches;
Height: 12 inches.

Power Requirements: 110 volts ac

References:

1. Warren, N. D., D. W. Atkins, J. S. Ford, and H. L. Wolbers, Development of a Training Program for Teaching Basic Principles of Troubleshooting, Technical Memorandum ASPRL-55-19, Armament Systems Personnel Research Laboratory, Air Force Personnel Training Research Center, Lowry Air Force Base, Colorado, October 1, 1955.
2. Warren, N. D., J. S. Ford, and D. H. Schuster, Development of a Trouble Locator and Evaluation of a Generalized Electronic Trouble Shooting Course, Technical Report AFPTRC-TR-58-1, Maintenance Laboratory, Air Force Personnel Training Research Center, Lowry Air Force Base, Colorado, 7 pages, AD No. 152 103, January 1958.
3. Warren, N. D., W. F. Dossett, and J. S. Ford, A Correlational Analysis of Achievement in a Generalized Electronic Trouble Shooting Course, Research Report AFPTRC-TN-57-148, Air Force Personnel Training Research Center, Lackland Air Force Base, Texas, 25 pages, AD No. 146 424, December 1957.
4. Warren, N. D., W. F. Dossett, and J. S. Ford, An Experimental Analysis of Achievement in a Generalized Electronic Trouble Shooting Course, Research Report AFPTRC-TN-57-147, Air Force Personnel Training Research Center, Lackland Air Force Base, Texas, 36 pages, AD No. 146 423, December 1957.


TEST METER
TEST SOURCE
TEST PROBE
POWER
ON
1
2
3
4
5
6
7
8
9
10
11
12
13
14
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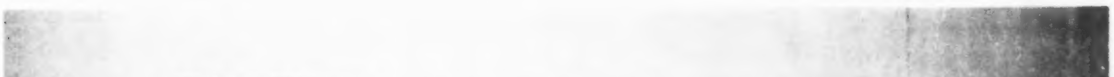
30

FRONT PANEL OF GETS TRAINER



BACK OF GETS TRAINER SHOWING MEANS FOR CHANGING DATA FLOW AND CONTROLS FOR INTRODUCING MALFUNCTIONS

OPTIMAL SEQUENCE TRAINER (OST)

Date: 1957-1959

Source: Not commercially available

Cost: Unknown

Originator:
H. R. LaPorte and D. H. Schuster
Department of Psychology
University of Southern California
Los Angeles, California

History: Developed as an inexpensive device to provide guidance and prompting in trouble-shooting training (cost of development about $200.00).

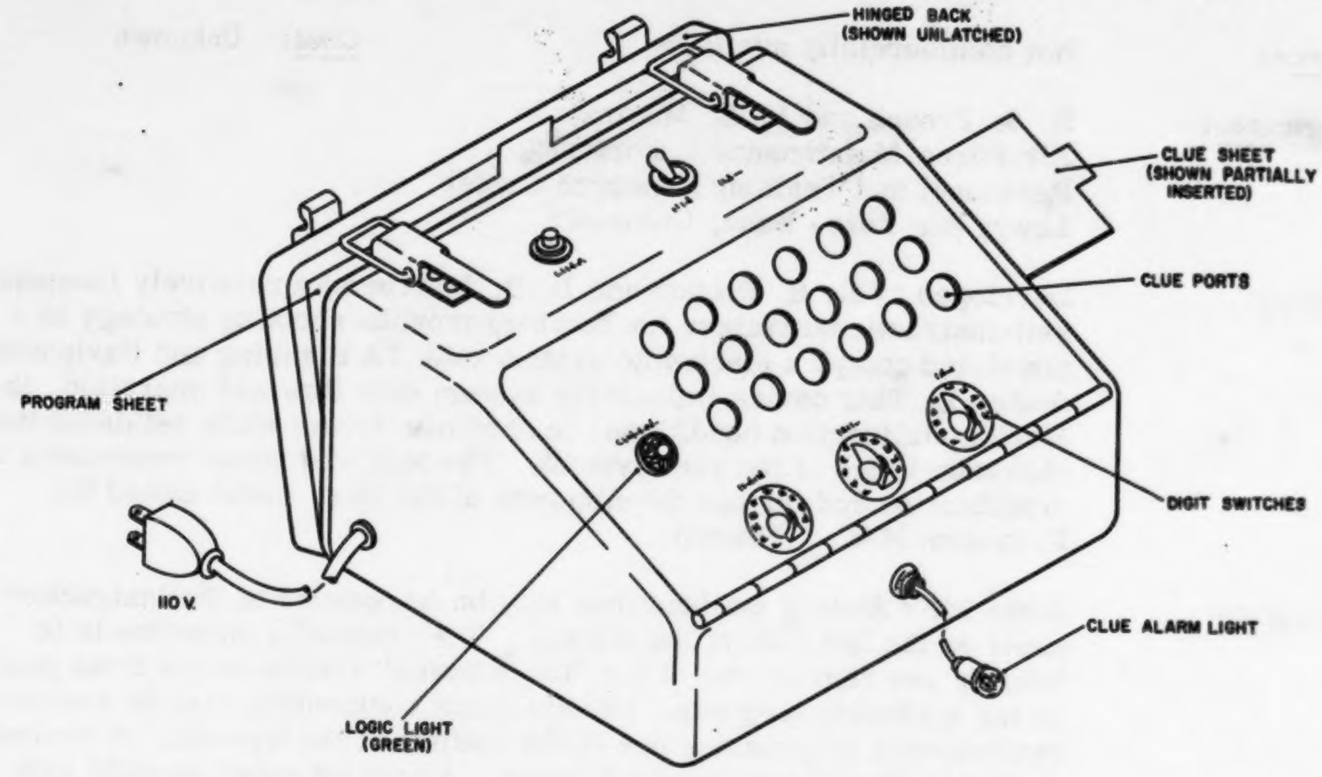
Operation: The instructional material is in the form of desired test point information given in code on schematic diagrams. The response mode is multiple-choice, 1 out of 1,000 settings of three 10-digit selector switches. The trainee sets the code number of his desired check into the OST. If that check is reasonable and correct, a green light comes on and the student tries another check. Prompting occurs when the clue lights come on at the end of 7 minutes. This happens if the trainee has been unsuccessful in trying to locate the best check point. The capacity of this device is 17 steps in a single trouble-shooting problem. The old program material can be easily substituted by new in a few seconds. There is no automatic scoring feature.

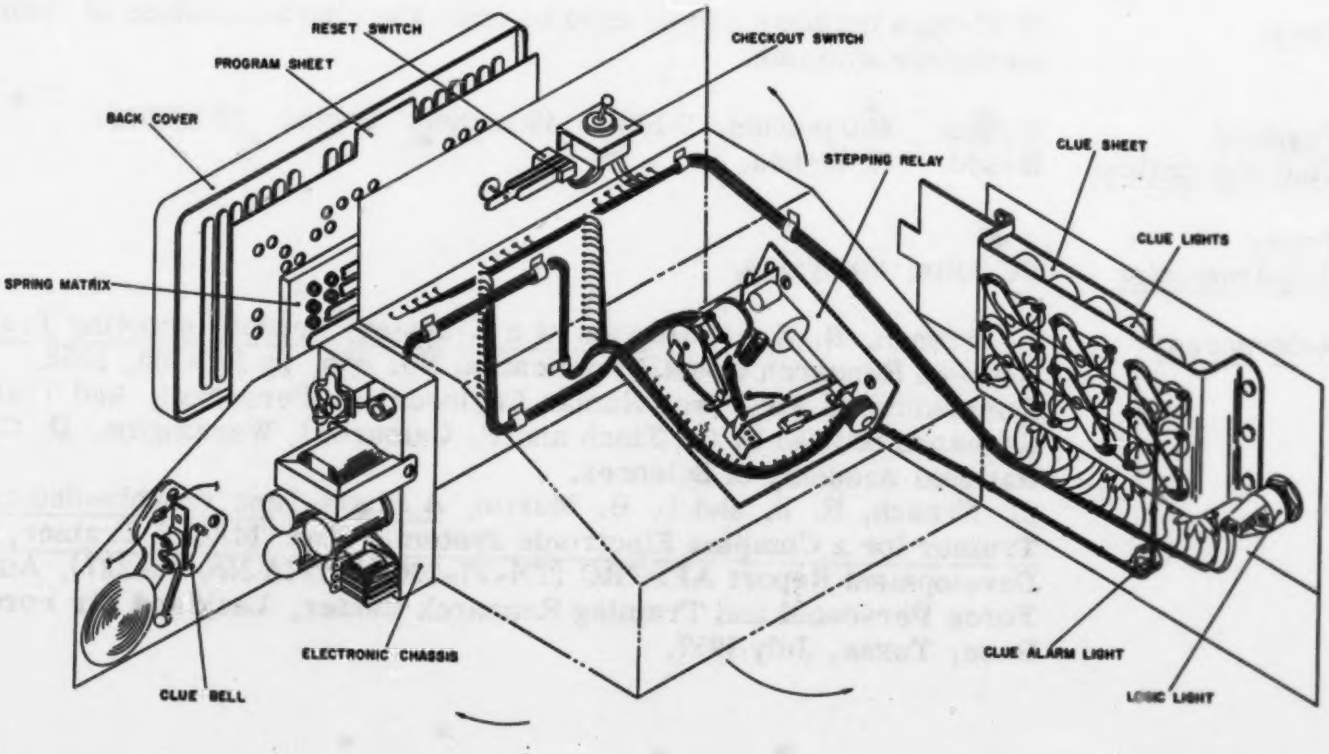
Uses: This device can best be used to teach sequential decision-making processes (eg, trouble-shooting or problem solving).

Physical Characteristics: Weight: 20 pounds; Width: 12-1/2 inches; Depth: 10 inches; Height: 9 inches.

Power Requirements: 50 watts, 115 volts ac.

Reference: Bryan, G. L. and D. H. Schuster, *An Experimental Comparison of Trouble Shooting Training Techniques,* Technical Report No. 30, prepared for Personnel and Training Branch, Psychological Services Division, Office of Naval Research, by Department of Psychology, University of Southern California, Los Angeles, California, December, 1959.


HINGED BACK
(SHOWN UNLATCHED)
CLUE SHEET
(SHOWN PARTIALLY
INSERTED)
CLUE PORTS
PROGRAM SHEET
DIGIT SWITCHES
110 V.
CLUE ALARM LIGHT
LOGIC LIGHT
(GREEN)


RESET SWITCH
CHECKOUT SWITCH
PROGRAM SHEET
BACK COVER
STEPPING RELAY
CLUE SHEET
CLUE LIGHTS
SPRING MATRIX
ELECTRONIC CHASSIS
CLUE ALARM LIGHT
CLUE BELL
LOGIC LIGHT

MALFUNCTION AND CIRCUITRY TRAINER (MAC TRAINER)

Date: 1956

Source: Not commercially available

Cost: Unknown

Originator:
R. S. French and L. B. Martin
Air Force Maintenance Laboratory
Personnel and Training Research Center
Lowry Air Force Base, Colorado

History: Developed by R. S. French and L. B. Martin as a relatively inexpensive self-instructional trainer for teaching trouble-shooting strategy in a simulated complex electronic system (MA-7A Bombing and Navigation System). This device represents system data flow and operation, including malfunction conditions, in symbolic terms while retaining the characteristics of the real system. The MAC-2 trainer represents a modification and further development of the first model called the K-System MAC-1 Trainer.

Operation: Some 200 different malfunctions may be introduced at the instructor's panel on the left side of the trainer. The trainee's objective is to identify and replace one of the "black boxes" visible on the front panel as the malfunctioning one. Other circuit components may be replaced symbolically by pressing one of the buttons at the top-left. A correct replacement will remove the trouble. A scoring panel on right side (not visible) maintains a record of the number and kinds of measurements made, the number of correct and incorrect replacement attempts, and the kinds of test instruments used. A special buzzer warns the trainee when he makes use of an inappropriate instrument for a given test.

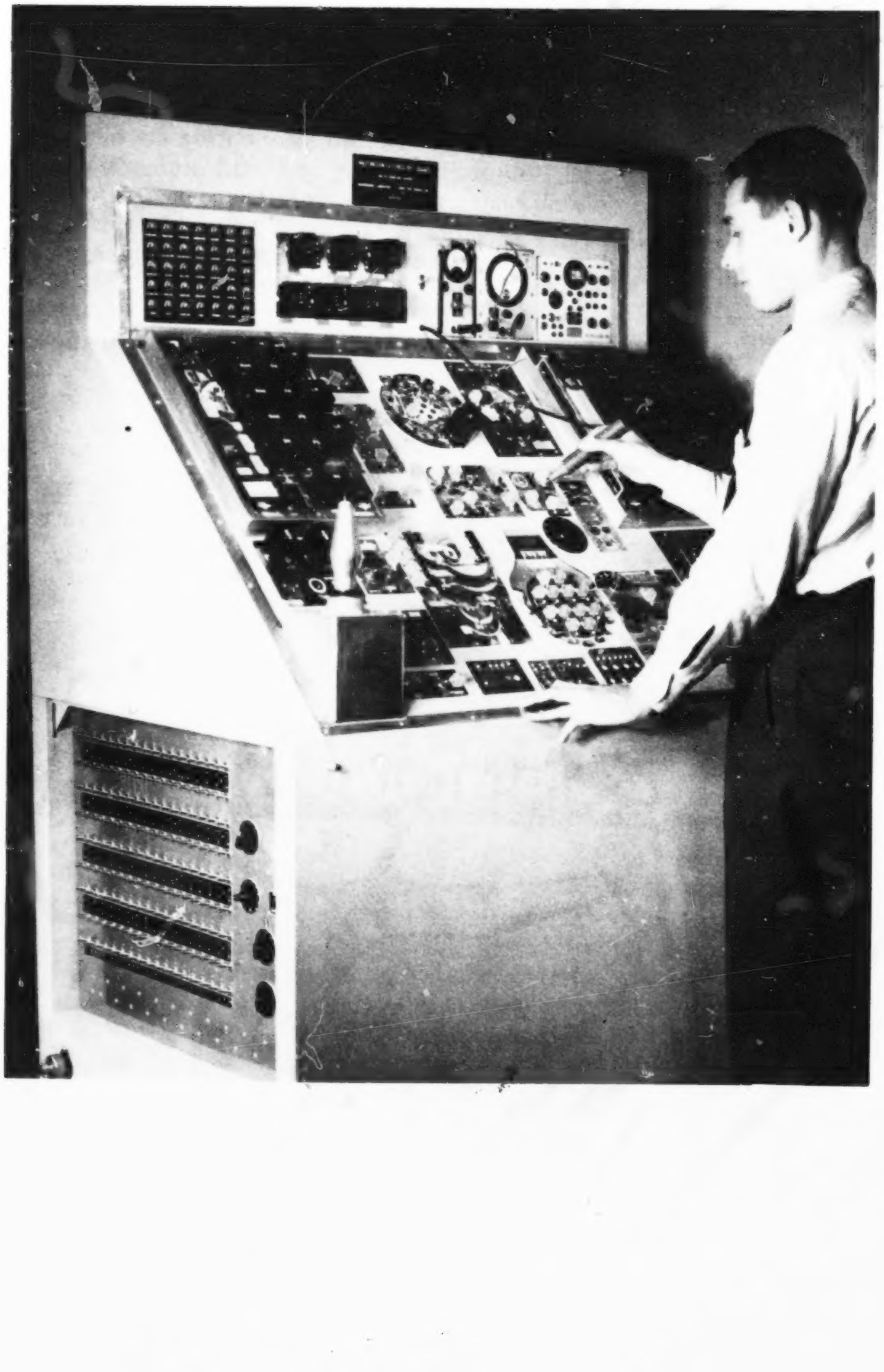
Uses: MAC-type trainers can be used to teach the characteristics of complex electronic systems.

Physical Characteristics: Weight: 400 pounds; Width: 45 inches; Depth: 30 inches; Height: 72 inches.

Power Requirements: 110 volts, 60 cycles.

References:

1. French, R. S., Evaluation of a K-System Trouble-shooting Trainer, National Research Countil Publication No. 455, pp 160-165, 1956, Symposium on Air Force Human Engineering, Personnel, and Training Research (Edited by G. Finch and F. Cameron), Washington, D. C., National Academy of Sciences.
2. French, R. S. and L. B. Martin, A Flight-Line Trouble-Shooting Trainer for a Complex Electronic System: The "MAC II Trainer," Development Report AFPTRC (TN-57-106) (ASTIA No. 134227), Air Force Personnel and Training Research Center, Lackland Air Force Base, Texas, July 1957.



POLYMATH

Date: 1957

Cost: Unknown

Source: Not commercially available

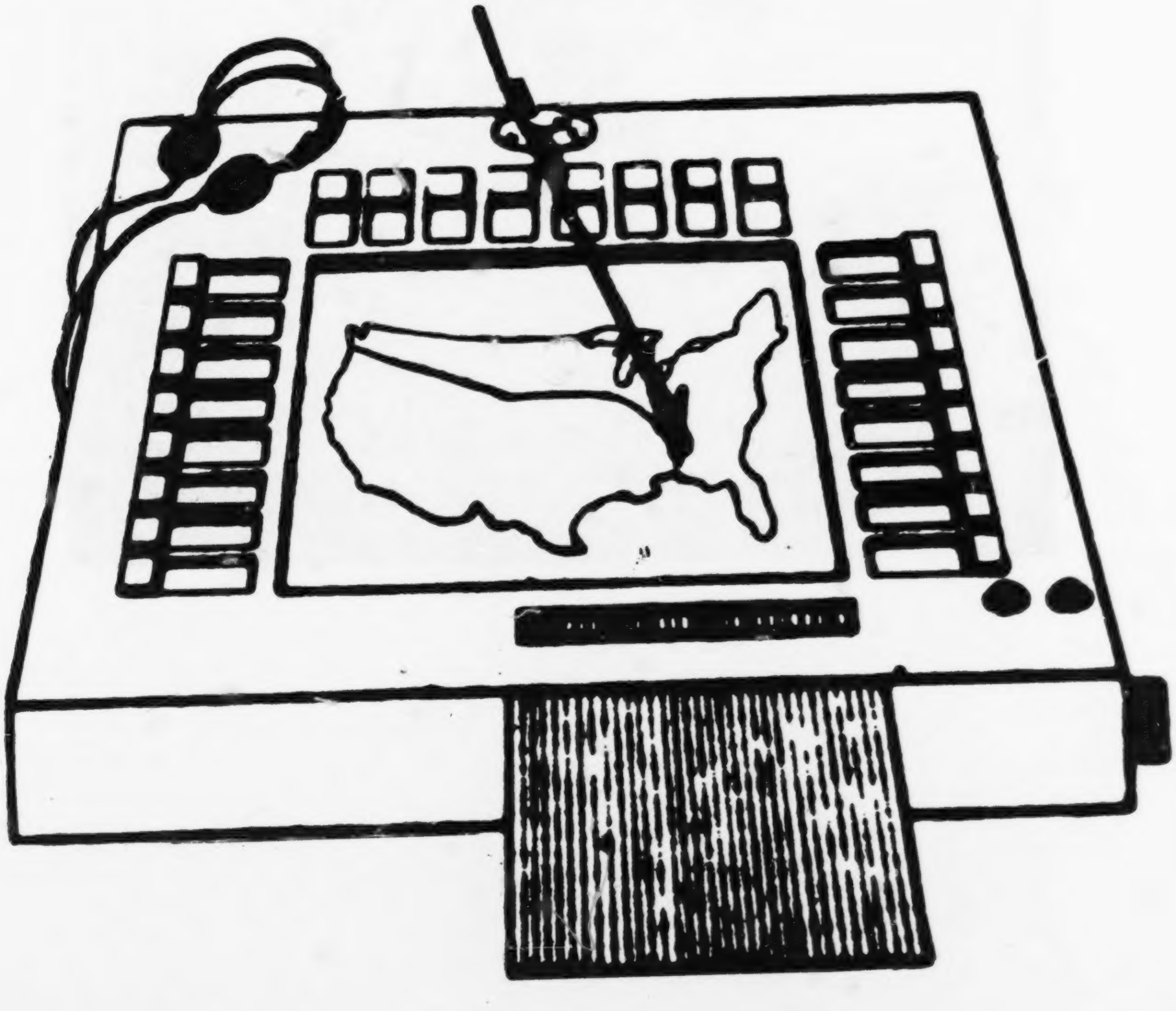
Originator:
E. Z. Rothkopf
Maintenance Laboratory
Air Force Personnel Training Research Center
Lowry Air Force Base, Colorado

Operation: Not a complete teaching machine, but a research device. Intended as a "flexible response gate" capable of accepting several "response languages." The Polymath can accept: (a) multiple-choice responses, (b) constructed responses of up to 29 letters, and (c) tracing responses as on a map or on a schematic diagram. Would serve as one of the components of a sophisticated auto-instructional system.

Physical Characteristics: Width: 30 inches; Depth: 27 inches; Height: 8 inches.

Power Requirements: 110 volts ac.

Reference: Lumsdaine, A. A. and R. Glaser, Teaching Machines and Programmed Learning: A Source Book, National Education Association of the United States, Washington, D. C., pp 13-14, 318-328, 1960.



TRAINER TESTER

Date: 1954

Source: Van Valkenburgh, Nooger and Neville, Inc.
15 Maiden Lane
New York 38, New York

Cost: Variable

Originator: Van Valkenburgh, Nooger and Neville

History: Developed by Van Valkenburgh, Nooger and Neville to teach Electronics in a Navy Electronics School.

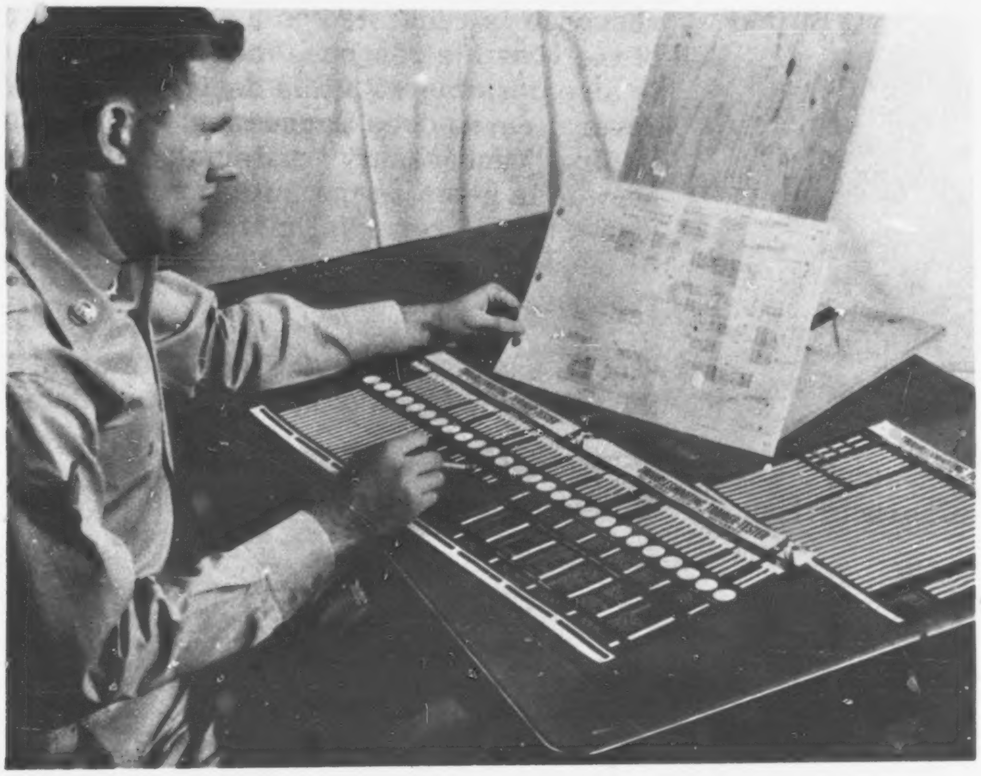
Operation: The Trainer Testers consist mainly of schematic diagrams (wiring and pictorial lay-out) of a particular electronic system. The Trainer Tester is divided into three main parts: "Trouble," "Symptoms," and "Remedy." The "Trouble" area contains a problem describing what has happened in the operation of the equipment to indicate that something is wrong. The "Symptoms" area lists the test points in the equipment and includes the resistance, voltage, and signal conditions at these points. Test data are concealed by covering strips of opaque overlay printing which must be erased to show the reading at any point. When the faulty part has been found, the code number of the part is then noted on the wiring or pictorial diagram, and the part is "replaced" with a new one. The "Remedy" area, which has concealed answers, will indicate whether or not the replacement of the part has corrected the trouble.

Uses: The Trainer Tester can be used primarily for the teaching of trouble-shooting procedures in electronic, hydraulic, or mechanical systems.

Physical Characteristics: Weight: 3 ounces; Width: 14 inches; Depth: Not Applicable; Height: 11 inches.

Power Requirements: None.

Reference: None.



AIR-OAO DEVICE — **Date:** 1960

Source: Not commercially available — **Cost:** Unknown

Originator:
H. H. Shettel and A. A. Lumsdaine
American Institute for Research
410 Amberson Avenue
Pittsburgh 32, Pennsylvania

History: Conceived and developed by H. H. Shettel and A. A. Lumsdaine under contract between American Institute for Research and Operational Applications Office of the Air Force Command and Control Development Division, Air Research and Development Command, Contract AF19(604)-5951. The purpose of the device was to "implement the presentation of small step, continuous-discourse self-instructional programs to provide on-the-site basic job knowledge and skill training for SAGE Track Monitor and Intercept Director operators."

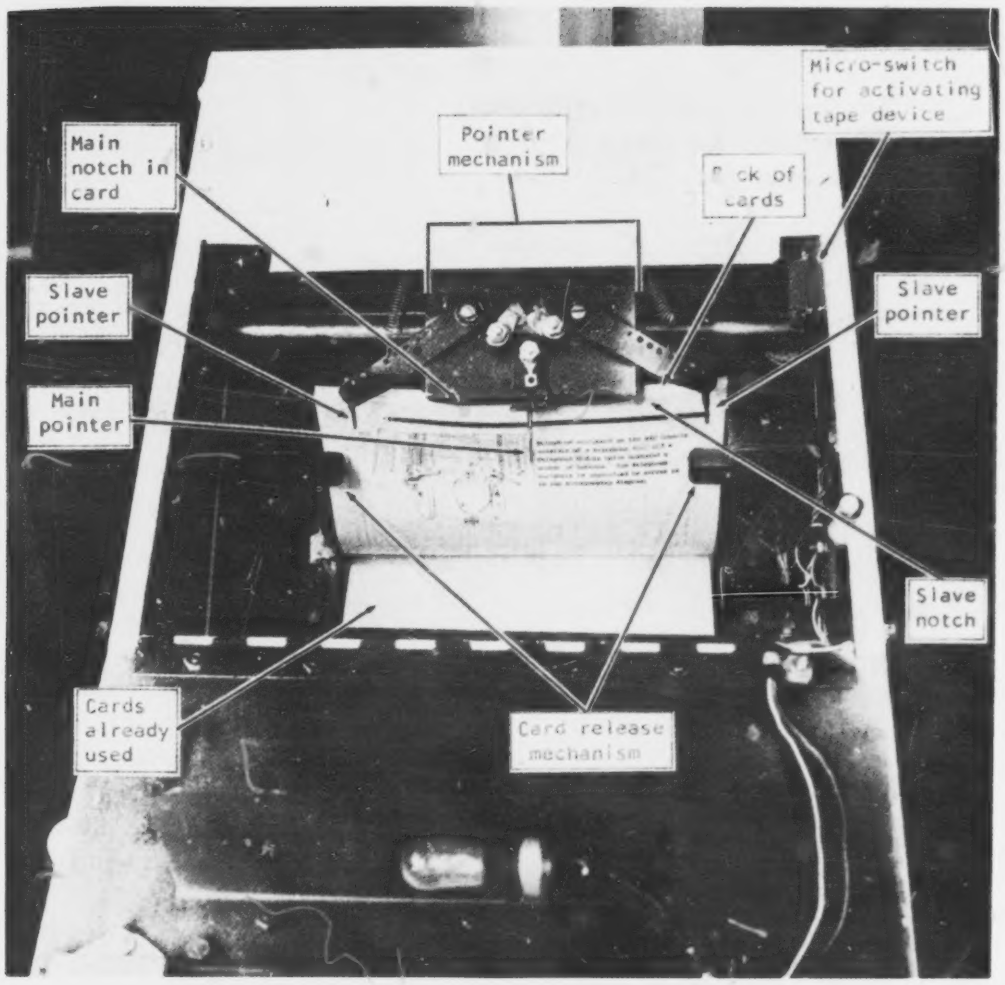
Operation: The instructional material is on 8-1/2 by 9-inch cards and can be seen through the front window. The trainee always indicates his response by moving the selection pointer to a position corresponding to his response choice. That choice can be made from a list of symbols, words, etc., or by selecting one of several dotted lines pointed directly to parts of illustrations or diagrams which are reproduced on the card itself. This device can present up to 19 alternatives per item. The next unit of material is presented by pulling the card-advance handle down. A card of new instructional material will come into view only if the trainee's response is correct. Otherwise the card of old material does not drop, hence, is presented again and the trainee must make a new choice. There is a counter which tallies a score every time the card advance handle is pulled. The total number of pulls minus the minimum possible would represent missed items. There is also a provision for writing on a paper tape which can be used when a written response is requested on a particular frame in the pack of cards. All of the possible response modes can be randomly intermixed. Branching is also possible with this device. If the trainee selects the right answer, several cards drop at once and he bypasses a number of frames containing "unnecessary" material. In cases where more than one wrong answer is given on the initial branch frame, the trainee, besides being shown all the remedial material, can be addressed to a specific frame or sequence that will be diagnostically remedial for that particular wrong response.

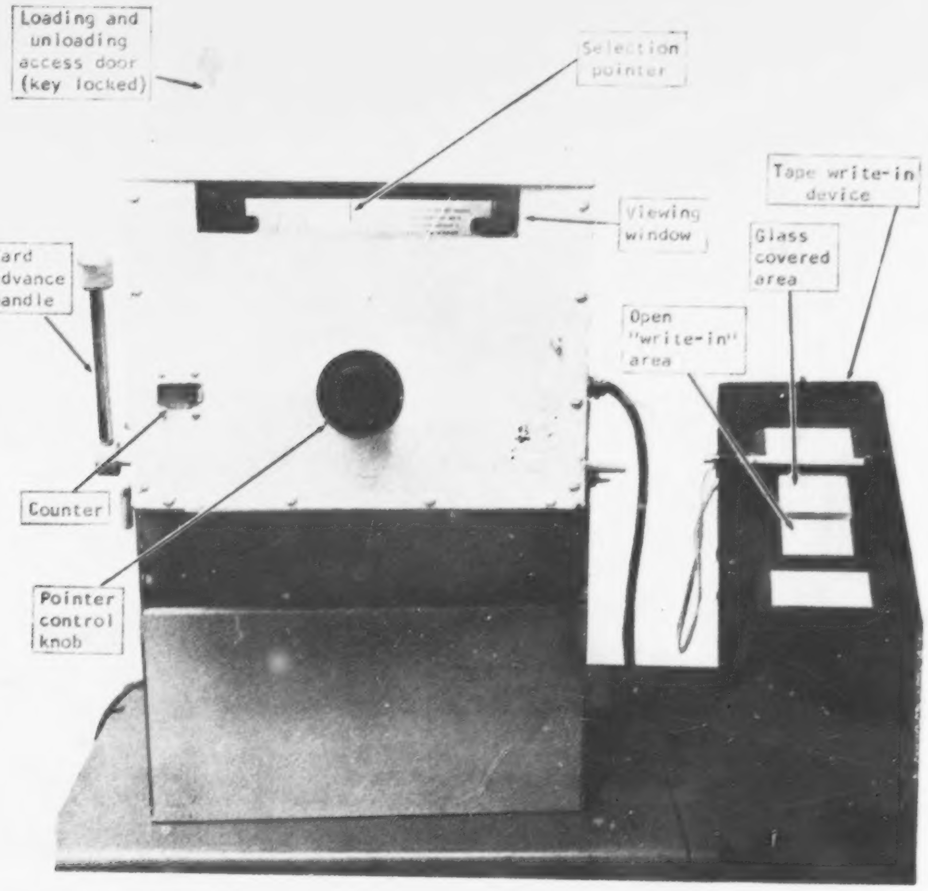
Uses: Can be used to provide on-the-site basic job knowledge and skill training for many types of operator or maintenance tasks.

Physical Characteristics: Weight: 65 pounds.

Power Requirements: 110-120 volts ac, 60 cycle.

Reference: None.


Main notch in card
Pointer mechanism
Pack of cards
Micro-switch for activating tape device
Slave pointer
Slave pointer
Main pointer
Slave notch
Cards already used
Card release mechanism


Loading and unloading access door (key locked)
Selection pointer
Tape write-in device
Viewing window
Card advance handle
Glass covered area
Open "write-in" area
Counter
Pointer control knob

DIDAK 101 PRE-VERBAL MACHINE

Date: 1959

Cost: Unknown

Source:
Rheem-Califone Corporation
1020 North La Brea Avenue
Hollywood 38, California

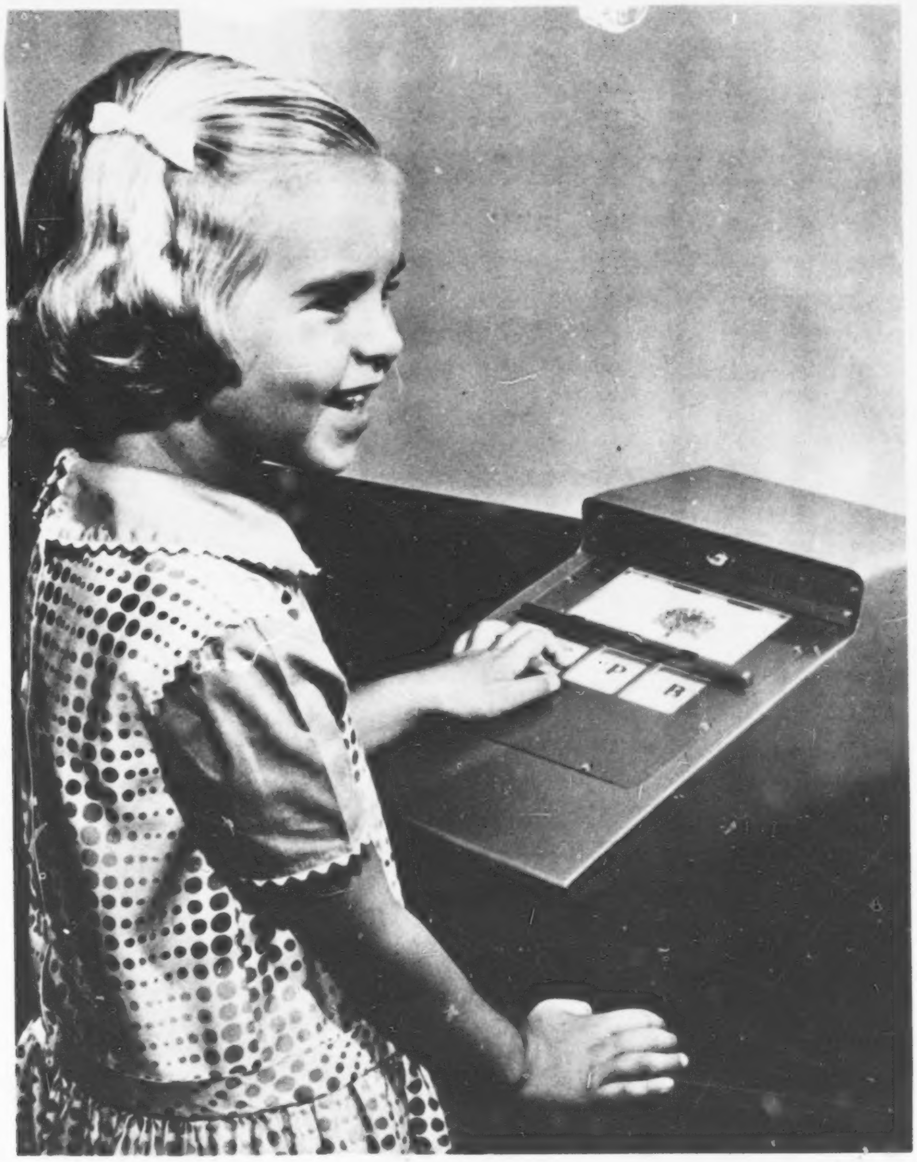
Originator: Rheem-Califone Corporation

Operation: A comparison stimulus (eg, a tree) appears in the top window. The learner must make a discrimination among three choices immediately below (eg, identify a letter appearing in the word "tree"). Only when the panel above the correct choice is pushed, does the next item appear. Otherwise the current item remains in view.

Physical Characteristics: Width: 12 inches; Depth: 20 inches; Height: 10 inches.

Power Requirements: 110 volts ac.

Reference: None.



SELF-CORRECTING EXERCISES

Date: 1959

Source: Not commercially available

Cost: Unknown

Originator: P. B. Diederich
Educational Testing Service
Princeton, New Jersey

History: Developed to teach English "fundamentals" in high school more rapidly and in a format that would require no mechanical device for presentation or correction.

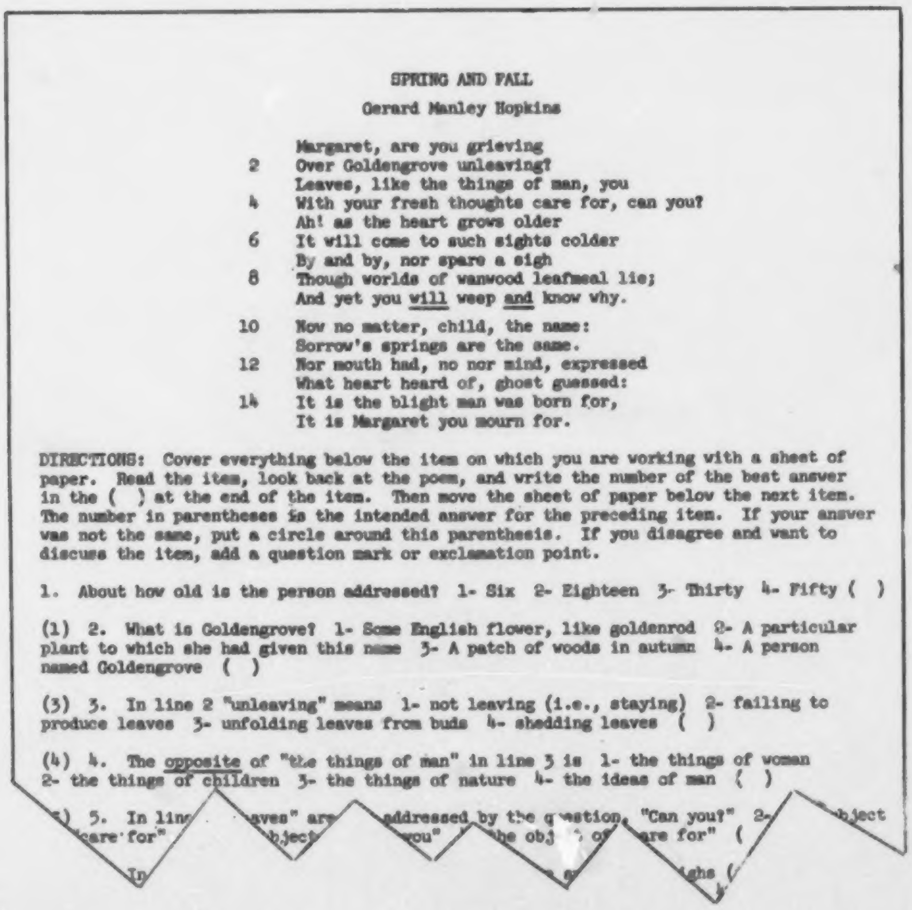
Description: The instructional material is printed at the top of the page with the questions beneath. The correct answer is printed below the question and is covered up with a sheet of plain paper or cardboard until the student has given his own answer. "Cheating" is prevented only by short tests, taken under regular test conditions in class, that cover the main points in the exercise with items different from those that were given in the instructional material. The instructional material is easy to mimeograph and prepare.

Uses: Well suited to drill material on English "fundamentals." Could be be adapted to other fields.

Physical Characteristics: Sheet of paper.

Power Requirements: None.

Reference: None.



SPRING AND FALL

Gerard Manley Hopkins

Margaret, are you grieving
Over Goldengrove unleaving?
Leaves, like the things of man, you
With your fresh thoughts care for, can you?
Ah! as the heart grows older
It will come to such sights colder
By and by, nor spare a sigh
Though worlds of wanwood leafmeal lie;
And yet you will weep and know why.

Now no matter, child, the name:
Sorrow's springs are the same.
Nor mouth had, no nor mind, expressed
What heart heard of, ghost guessed:
It is the blight man was born for,
It is Margaret you mourn for.

DIRECTIONS: Cover everything below the item on which you are working with a sheet of paper. Read the item, look back at the poem, and write the number of the best answer in the ( ) at the end of the item. Then move the sheet of paper below the next item. The number in parentheses is the intended answer for the preceding item. If your answer was not the same, put a circle around this parenthesis. If you disagree and want to discuss the item, add a question mark or exclamation point.

1. About how old is the person addressed? 1- Six 2- Eighteen 3- Thirty 4- Fifty ( )

(1) 2. What is Goldengrove? 1- Some English flower, like goldenrod 2- A particular plant to which she had given this name 3- A patch of woods in autumn 4- A person named Goldengrove ( )

(3) 3. In line 2 "unleaving" means 1- not leaving (i.e., staying) 2- failing to produce leaves 3- unfolding leaves from buds 4- shedding leaves ( )

(4) 4. The opposite of "the things of man" in line 3 is 1- the things of woman 2- the things of children 3- the things of nature 4- the ideas of man ( )

5. In lin aves" are addressed by the question, "Can you?" 2- bject
care for" bject you" he obj of are for" (

In ghs (

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APPENDIX

PATENTS OF TEACHING AND TESTING DEVICES*

NO.	TITLE OF PATENT	INVENTOR	PATENT NO.	PATENT DATE
1.	Improvement in Apparatus for Teaching Spelling	H. Skinner	52,758	Feb. 20, 1886
2.	Educational Apparatus	I. S. Kinch	309,064	Dec. 9, 1884
3.	Automatic Instructor	W.L.Gates	319,224	June 2, 1885
4.	Kindergarten for Teaching Spelling	H. H.Steele	792,801	June 20, 1905
5.	Machine for Intelligence Tests	S.L.Pressey	1,749,226	Mar. 4, 1930
6.	Psychological Test Machine	H.C.Lavery et al	1,929,872	Oct. 10, 1933
7.	Educational Device	J.P.Buckley	2,060,974	Nov. 17, 1936
8.	Spelling Toy	F.F.C.Rippon	2,213,411	Sep. 3, 1940
9.	Educational Device	W.C.Shipley	2,221,303	Nov. 12,1940
10.	Testing Machine	J. S. Kopas	2,311,055	Feb. 16,1943
11.	Quiz Game	G.W.Emmert	2,311,217	Feb. 16,1943
12.	Quiz Machine	B.E.Mills	2,401,434	June 4, 1946
13.	Scoring Device	W.Zimmerman	2,509,405	May 30, 1950
14.	Self-Examination Device	M.Fleischer	2,546,666	Mar. 27,1951
15.	Coded Card Handling Machine	M.C.Williams et al	2,564,089	Aug. 14, 1951
16.	Teaching Machine	H.M.Davis	2,687,579	Aug. 31, 1954
17.	Psychological Tests Taking Desks	R.G.Genest	2,715,784	Aug. 23,1955
18.	Classroom Communicator	F.T.John et al	2,738,595	Mar. 20,1956
19.	Variable Difficulty Devices	S.Hamilton	2,826,828	Mar. 18,1958
20.	Teaching Machine	B.F.Skinner	2,846,779	Aug. 12, 1958
21.	Subject-Matter Trainer	G.G.Besnard et al	2,877,568	Mar.17, 1959
22.	Scoring Device and Method	C.F.Willey	2,936,532	May 17, 1960

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*Although no claim is made that an exhaustive patent search was conducted, this list is believed to cover most of the pertinent patents in this area.

ASD TR 61-414

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Aeronautical Systems Division, Aerospace Medical Laboratory, Wright-Patterson Air Force Base, Ohio
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Unclassified report

This report summarizes the state of the art of auto-instruction and teaching devices and catalogs instructional devices to April 1961, in the interest of suggesting possible applications to local training or educational problems. The first section briefly reviews what auto-instruction is, whether it is an entirely new

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concept, its practical benefits, auto-instruction terminology, programs and devices, current programming formats, evaluating a program, and discusses prospects for the future of auto-instruction. The second section catalogs and describes all major current auto-instructional devices: Skinner machines, Pressey machines, Crowder technique, self-organizing systems, audio-visual machines, digital computers as teaching machines, and miscellaneous devices. A list of teaching machine patents is appended.

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